Engineering News

VOLUME 69 FEBRUARY 20, 1913 NUMBER 8

Yakima Indian Reservation Drainage Project

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SYNOPSIS—Over-use of water for irrigation having turned productive farms on the Yakima Indian Reservation, Washington, into swamps and barren alkali flats, a drainage system was constructed by the U. S. Indian Service. Interesting facts concerning the earlier and later irrigation works and regarding the design and construction of the drainage works are given, including cost figures for the latter.

The Yakima Indian Reservation is located near the central part of the State of Washington. Its eastern boundary is formed by the Yakima River, which flows in a southeasterly direction and discharges into the Columbia River at a point about 45 miles east of the southeast corner of the reservation.

The reservation was set aside by treaty in 1855 in order to bring together the major part of the more or less savage Indians of various tribes who were at that time roving promiscuously over the central part of the state. The treaty specifically declares it to be the government's intention to encourage and assist the Indian in every way possible along the lines of agriculture, even to the extent of establishing an agricultural and industrial school, a wagon and ploughmaker's shop, the appointment of a superintendent of farming, and two farmers, etc., etc. From the records it appears that from the date of the treaty, farming to a greater or less extent has been carried on and developed within this reservation, encouraged and assisted by the United States Indian Service.

The reservation comprises something over a million acres and varies in topography from high mountainous timbered and grazing lands on its western border to very rich irrigable smaller valleys bordering on the Atanum, Simcoe, Toppenish and Satus creeks, with an extensive area on which the drainage project was constructed, comprising about 130,000 acres of very rich land sloping about 10 ft. to the mile, in a southeasterly direction, and situated at an average altitude of about 850 ft. above sea level.

This body of land, measuring about 15 miles north and south, and extending west from the Yakima River for a distance of about 15 miles, is bounded on the east by the Yakima River, and is readily irrigable by gravity and easy pumping from that source. The annual precipitation is only some 8 in., most of which falls during the winter season.

Fig. 1. Drainage Canal of Yakima Indian Reservation, Washington, Near Outlet into Yakima River

This large body of irrigable land is bounded on the south by Toppenish Ridge, a low spur, at the north base of which flows Toppenish Creek, a small reservation stream which includes Simcoe Creek, and in all drains about 240 sq.mi., finally emptying into the Yakima River. It is bounded on the north by the Atanum Ridge, along the northern base of which flows Atanum Creek, and hemmed in to the west by the higher mountainous country forming the western part of the reservation. A portion of the reservation is shown by the map, Fig. 1. This land is very favorably located regarding transportation and market facilities, and is so situated as to be easily irrigated almost immediately after the canal leaves the river, thus eliminating the usual very expensive and generally undesirable long line of feed canal so often necessary in connection with irrigation projects of similar magnitude. A more or less extensive stratum of water-washed gravel underlies the whole area, being close to the surface at the upper or northern part, and at varying depths in the lower slopes.

For about a mile to the north of Toppenish Creek a

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strip exists where the soil is quite deep, acting as a submerged barrier to the free drainage of these gravels generally underlying the territory to the north.

Prior to the era of extended irrigation over the upper section of this body of land, the lower lands, along the north side of Toppenish Creek, were chosen by the Indian allottees and generally considered by the whites as the most desirable and productive on the reservation. I have been told by old residents that even on this lower belt within two or three miles from Toppenish Creek, in some cases in the earlier days, it was necessary to sink a well from 20 to 40 ft. in depth in order to get water. This is illustrative of the dryness of this territory prior to the period of more general irrigation on the higher parts of this body of land. As these lands became allotted, they were gradually cultivated through irrigation by a canal from theYakima River, built in the earlier days by the Indians without outside assistance. In the early 90's, the Yakima Indians, through the disposal of some tribal fishing grounds farther north on the Yakima River, became possessed of about $20,000 in cash, which it was decided to use for the benefit of those whose allottments were so located along the Yakima River as to require an expenditure for irrigation larger than they were able to afford. Acordingly there was constructed, in 1893, what is known as the Old Reservation or Irwin Canal, of 10 or 12 miles more or less in length, and with a capacity of about 150 sec.-ft. This canal was built under the supervision of a former Indian Agent by the name of Irwin. It tapped the Yakima River at a point about four miles downstream from the northeast corner of the reservation, and has been developed from time to time, so that at present it is capable of covering from 12,000 to 15,000 acres or more of very choice agricultural lands. A report from the Indian Agent in 1897 regarding this canal shows that in that year alone about 20 miles of extensions and laterals were constructed, also its capacity had been increased to approximately 300 sec.-ft., and the report further states that by further extension and lateral construction, it will be possible to cover about 50,000 acres of rich land.

This canal was constructed to serve lands from its headworks to the Toppenish Creek, and considering the conditions under which it was built and extended, has certainly performed a service most creditable. Prior to and subsequent to the construction of this canal, many smaller ditches have been taken out at various points along the Yakima River or its tributary sloughs and small creeks by Indian allottees and white lessees of Indian lands.

Beginning with about the year 1903, ten years after the start on the construction of the Irwin Canal, the chief engineer of the Indian Service, W. H. Code, was enabled by small annual congressional appropriations, to construct at a point farther up the river, just south of the northeast boundary of the reservation, substantial masonry headworks and a canal of about 650 sec.-ft. capacity, skirting the southern base of the Atanum Ridge, to cover the larger irrigable area. This canal and headworks were constructed in order to be easily capable of covering some 60,000 or 70,000 acres of land to the north and west of the land already covered by the Irwin Canal.

The Yakima River, draining a mountainous timbered territory, and being fed through the generally slow melting of accumulated snows, usually continues to flow at a flood stage of sufficient quantity to accommodate all the irrigable lands along its course until about the middle of June or the first of July of each year, after which time its flow quickly diminishes with the exception of occasional uncertain autumn floods brought about by heavy rains in the upper mountainous regions.

As the low-water stage of the Yakima River unfortunately occurs at the height of the irrigation season, a general water shortage has in the past been experienced throughout the valley at the most critical period of the crop-maturing season. This difficulty is now being overcome by the construction of storage reservoirs by the Reclamation Service, in the upper reaches of the Yakima River to augment the regular low-water flow.

This condition of low water in the past has been a very strong natural factor in causing the farmer to over-irrigate in the earlier part of the season when the water was plentiful, in the hope that by using a large amount of water when it was available he might be able to more strongly fortify his growing crops, usually alfalfa, against the ordinary later shortage with its attendant extremely dry, hot weather. Also, as the generally underlying free gravel exists either very close to or at the surface, especially on the upper part of this irrigable area of the reservation, more water is necessary for irrigation on this body of land than at other points in the Yakima Valley, where the soil is deeper and the underlying gravel does not exist.

At this point it seems proper to mention that the irrigation work of any magnitude on the Reservation to date has been constructed and developed from time to time through the aid of uncertain small congressional appropriations which necessarily enforced a policy demanding the best results for the time being at a minimum cost. Further, due to the gravelly nature of the territory, an appreciable mileage of the lateral canal system had to be constructed through occasional beds of loose gravel and as sufficient funds have never been available to make these canals water-tight, an appreciable seepage occurs. This, of course, is a factor in requiring more water than would otherwise be necessary, and it also adds to the amount of seepage to the lands situated at a lower altitude which thus became swamped and alkalied as the upper irrigation was developed. However, no matter what may be done to make the canals proof against seepage, the naturally loose soil with its favorable slope to the south and closely underlying extensive depth of a loose gravelly constant natural drain, will always be a factor to be taken into consideration in measuring the future irrigation water-supply needs for this area.

In the earlier days of limited irrigation, the underlying gravels were able without any noticeable detriment to the lower lands to dispose of such seepage as found its way from the upper parts of the reservation, but with the constant gradual development of this irrigated area (about 40,000 acres at present) the seepage, of necessity, rapidly increasing, became more than could be taken care of by the natural gravel outlet. This, consequently, caused a rapid rise in the water plane at the lower elevations, beginning near the Toppenish Creek, and gradually encroaching to the north from year to year as the irrigated area increased. This condition became so serious that in the year 1909 the water-logged and alkalied area had encroached far enough to the north to have made worthless an area covering about 40,000 acres of what had previously been as productive land as could be found any-

where under similar climatic conditions. Where previously prolific grain crops higher than a man's head were possible, with irrigation an absolute necessity, the same ground had become as barren as a floor through the new condition. On these now barren, alkalied and swampy areas, which formerly were cultivated ranches, can be seen deserted Indian homesteads, with their attendant typical Western corrals and sheds rapidly falling to pieces through abandonment and lack of use.

This area in the year 1909 covered a distance of approximately 20 miles along Toppenish Creek and extended back for a distance of from one to four miles. It had been studied and surveyed by the U. S. Reclamation Service at different periods prior to this time. Through the urgent appeals of some of the more advanced Indians and enterprising resident whites, this condition was quite forcibly brought to the attention of former Secretary of the Interior, Ballinger, who, after a full realization of the importance of quick action through a visit to the locality, with the coöperation of Senator Wesley L. Jones, obtained a reimbursible appropriation from Congress of $250,000, in the spring of 1910, to become immediately available for the relief of this precarious situation. Upon assurance of the appropriation, the writer was immediately detailed in May, 1910, by Chief Engineer of the Indian Service, W. H. Code, to proceed to the reservation and make surveys and test borings and compile all available necessary data for subsequent consideration in formulating definite plans for construction.

To give an idea of the condition of the affected territory at that date, it may be stated that in making the surveys through the previously cultivated and prosperous ranches, it was often necessary to wade waist deep in mud and water, and the horses occasionally became mired so that their backs were submerged in the bogs.

The test borings were carried along with the surveys in order to locate a line, if possible, where the bottom of a prospective drainage canal would tap the underlying gravel. It developed that a blanket of alluvial soil of appreciable depth of a volcanic ash and cinder nature existed for a distance of one or two miles from the creek, consequently the canal line was run farther to the north, favorable for successful drainage. Due to the natural where gravel conditions were found to be much more slope of the surface, it was found to be quite feasible to construct a main canal from the Yakima River practically due west, with laterals on the section lines about every two miles in a northerly direction. As the highways in this locality usually follow the section lines and the natural slope of the lands is to the south and west, the canals were laid out and constructed on the north and west sides of the section lines with a view to local connection possibilities whenever found necessary with the minimum number of highway crossings.

Further, as the irrigation canals for proper service will, of necessity, be located on the south and east sides of the section lines, the highways can be quite conveniently laid out between the two canals, allowing for a very profitable use of the spoil banks of the canals which happen in most cases to be naturally adaptable for favorable highway construction.

On the completion of the surveys and borings, a consulting board of engineers was convened on the ground, comprised as follows: W. H. Code, chief engineer U. S. Indian Service; D. C. Henny, consulting engineer U. S. Reclamation Service; C. H. Swigart, supervising engineer U. S. Reclamation Service; C. G. Elliott, drainage expert U. S. Agricultural Department, and the writer, with the results that definite lines for the canals were established, size of main canals and laterals adopted, and type of machines for prosecuting the work approved.

In earlier studies the widening and deepening of Toppenish Creek for use as a main drainage channel had been suggested, but due to gradient and annual flood conditions, it now appeared advisable to construct an independent drainage canal to provide for the new condition, parallel to and to the north of the creek, thus leaving the creek for the present in its natural condition to take care of its 240 sq.mi. of watershed as heretofore.

It appeared advisable to use a floating dipper dredge for the more swampy locations, and a drag-line excavator for the lands not so wet; starting at the western end with the floating dredge and working toward the Yakima River and starting at the Yakima River with the drag line and working west toward the dredge.

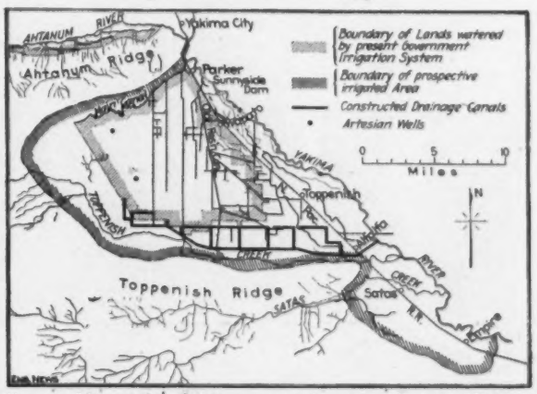


FIG. 2. MAP OF A PART OF THE YAKIMA INDIAN RESERVATION, WASHINGTON, SHOWING IRRIGATION AND DRAINAGE SYSTEMS

The main canal (see Fig. 1), 10 ft. bottom width and 9 ft. deep, was located from one to two miles and more north of and practically paralleling Toppenish Creek, where the gravel was nearer the surface than it was at locations which were closer to the creek.

As the yardage to be moved was large, probably some 2,000,000 cu.yd., it was considered desirable to take advantage of the experience gained with different excavating machines on the construction of the New York State Barge Canal. Consequently the writer was detailed East by direction of the chief engineer to investigate and report regarding the purchase of the most favorable machines for prosecuting the work. Due to urgent need for immediate action, it was considered desirable to purchase the necessary machinery and prosecute the work by our own forces rather than wait to take the time necessary for preliminaries, such as would have been required should it have been decided to do the work by contract.

Proposals for the drag-line excavator were called for, to be opened July 25, 1910, for a structural-steel drag-line excavator with 60-ft. boom, 1½-yd. bucket, the bucket to be stiff and strong, machine to be fitted with hardwood skids and provided with rollers and equal to or better than the Lidgerwood, Crawford, Browning or Marion

steam-shovel companies' standard makes, and to be fully guaranteed in every respect.

Proposals were also invited for a standard floating dipper dredge of 1 yd. capacity.

It was decided to purchase the Lidgerwood Crawford, Class B, excavator, for $8875, without engine house, it being decided to use a galvanized corrugated-iron house in place of the ordinary wood house furnished by the company, to minimize fire dangers.

It was also decided to purchase a Marion standard 40-ft. boom, 1-yd. dipper dredge, with bank spuds, operating on a hull 60 ft. by 18 ft. wide by 5½ ft. in depth, at a price of $5000 for the machinery complete f.o.b. Marion, Ohio.

As a local contractor had just finished some work on a drainage proposition, a short distance down the river, consequently having available a drag-line excavator of 40-ft. boom, and 1 yd. bucket capacity, the machine was leased and put to work on the construction of the laterals, with very satisfactory results.

The drainage results on this work have been satisfactory beyond what was anticipated by the most optimistic. Sloughs and swamps were lowered and completely dried 1½ miles from the ditch.

FIG. 3. CONCRETE CULVERT CARRYING DRAINAGE CANAL UNDER A SLOUGH AND BENEATH TWO ROADWAYS

In laying the work out on the ground, C. G. Elliott, former drainage expert of the Agricultural Department, who was called in consultation, emphasized the importance of taking advantage of the intercepting features of the drainage canals to the extent of locating the canals where they might serve lands below as well as those above the ditch.

This feature was very noticeably prominent as the work progressed, for swamps, sloughs and the land in general for a mile below the canal were affected just as freely through the intercepting qualities of the canal as the lands above.

Due to appearances of the alkalied lands, very few had much hope of the early reclamation of the badly affected lands without persistent and continuous washing and treatment of some kind, but the reverse turned out to be the fact. Before the approach of the drainage canal some tracts were impassably boggy and covered with a black alkali to the extent of being absolutely devoid of of any vegetation whatever, but with the approach of the drainage ditch in the winter the land became dust dry, making irrigation necessary in the following spring, and a very creditable crop was raised the same year without any treatment beyond ordinary irrigation. Equally successful results were obtained with potatoes on a former berry tract that had been completely destroyed through the action of the alkali salts. The drainage system was the means of reclaiming lands that could not find purchasers at any price under the swampy alkali conditions, the reclaimed lands selling at prices varying from $50 to $200 and more per acre.

While it is hardly fair to judge what the permanent future flow may be from the present discharge, it is confidently expected that a good substantial permanent flow will result. The present total discharge is somewhere in the neighborhood of 200 cu.ft. per sec. from about 40 miles of drainage canal.

Fig. 3 shows a reinforced-concrete culvert carrying the main drainage canal under Wanity Slough and two roadways, Wanity Slough being an old reservation natural drainage slough emptying into Toppenish Creek and carrying too much water to be cared for by the drainage canal. This culvert has a clear opening 39 in. deep and 20 ft. wide, and has a length of 75 ft. Its total cost was $4039.

As the work was practically completed and the accounts balanced at the close of the fiscal year, it appears more convenient to give the cost and construction data to June 30, 1912.

A light highway bridge, similar to the one shown in Fig. 2, was used throughout and constructed at a total average cost of about $150.

The following are the detailed costs and construction data of the three machines:

Marion Dredge—1-yd. dipper dredge, 40-ft. boom. Limit of dump above water 15 to 18 ft. Limit of digging below water, 12 ft. Center of hull to center of dump, 35 to 40 ft. Size of hull, 60x18x5½ ft. About 24,000 ft. B. M. lumber required in construction of hull.

Cost of machinery f.o.b. Marion, Ohio, $5000. Cost complete with hull in working order about 8 miles haul from the railroad (exclusive of freight charges on machinery from Marion, Ohio, to Toppenish, Wash.), $10,034.

Started to excavate, Nov. 17, 1910, and worked steadily till Mar. 13, 1912, usually excavating in soft material with gravel subsoil and occasional streaks of hardpan. Results: gravel subsoil and occasional streaks of hardpan. Results:

Total cu.yd. excavated	502,911
Total lin.ft. of canal	57,944
Total 8-hr. shifts operating	823

		Cost of Work Total	Per cu.yd.
Field supervision, including clerical		$2,896.08	0.005
Labor operation		18,816.40	0.0374
Hardware, tools, etc.		1,138.50	0.0023
Repairs, shopwork, etc.		1,850.79	0.0037
Camp maintenance		960.00	0.0019
Coal, about $4.85 per ton delivered	$8224.00		
Cable	2368.00		
Oil, waste, etc.	784.00		
Carbide for lights	558.00	11,934.00	0.0236
		$37,595.86	0.0739

No depreciation charges have been added, but it is believed that from 1 to 1½c. per cu.yd. would cover this item.

Leased Machine—This machine was constructed by the Washington Iron Works, of Seattle, Wash. It had a 50-ft. boom, with 1 yd. channon bucket, operated by a 7x10¼-in. double engine. The machine was mounted on skids and hauled back by an independent engine mounted on the rear. It was started in September, 1910, and finished on expiration of lease, Apr. 15, 1912.

The material excavated comprised volcanic ash with occasional streaks of hardpan that required blasting, underlaid with loose gravel.

Total cu.yd. excavated	539,235
Total lin.ft. of canal	68,590
Total 8-hr. shifts operating	917

	Cost of Work Total	Per cu.yd.
Field supervision, including clerical	$3,275.76	0.0060
Labor operation, including $225.00 rent per mo.	32,320.68	0.0602
Hardware, tools, etc.	1,532.33	0.0028
Repairs and shopwork	5,845.02	0.0108
Camp maintenance	1,386.05	0.0025
Coal, about $4.85 per ton delivered Cable Oil waste, etc. Carbide for lights	14,151.60	0.0262
	$58,511.44	0.1085

Due to layout of canals, this machine moved empty about 2½ miles, which expense is included in above costs.

Lidgerwood Class B. Drag Line Excavator—This machine (Fig. 4) complete for operation on the ground about two miles haul from railroad, exclusive of railroad transportation from Chicago, cost $11,555.

The material excavated compressed volcanic ash soil with

FIG. 4. LIDGERWOOD DRAG-LINE EXCAVATOR WORKING ON YAKIMA DRAINAGE CANAL

occasional streaks of hardpan, underlaid with loose gravel. The machine started to operate Oct. 1, 1910, and the data are given to June 20, 1912.

Total cu.yd. excavated	789,968
Total lin.ft. of canal	92,305
Total 8-hr. shifts operated	1,024

	Cost of work	
	Total	Per cu.yd.
Field supervision and clerical	$3,617.45	0.0046
Labor operation	27,562.65	0.0352
Hardware, tools, etc.	3,026.33	0.0038
Repairs and shopwork	10,007.33	0.0125
Camp maintenance	1,449.00	0.0018
Coal, Cable, Oil waste, etc., Carbide for lights	18,097.40	0.0229
	$63,760.16	0.0808

No depreciation has been charged in the above, but it is believed that about 1½c. per cu.yd. should cover this item.

This machine moved empty, a total distance of about 18 miles, which expense is included in the above costs.

As a matter of general interest the following is sub-

FIG. 1. BRICK SEWER UNDER CONSTRUCTION, MORELL ST., DETROIT, MICH., SHOWING SECTION DESTROYED BY EARTH SLIDE

mitted as showing the total amounts expended from the original appropriation of $250,000 to June 30, 1912:

Inventory on hand	$22,535.90
General miscellaneous	1,867.07
Bills paid by Washington office	2,745.05
Excavation	159,867.46
Clearing	4,786.74
Miscellaneous culverts and crops	4,891.19
38 highway bridges	5,095.49
Fence moving and replacing	3,343.68
Engineering	14,462.97
	$220,215.55

It may be of interest to note that the total amount disbursed, including engineering, structures, clearing, fence moving and inventory, which covers all depreciation, aded to the excavation, shows a cost of about 12c. per cu.yd. when applied wholly to the excavation.

The work was prosecuted under the direction of Former Chief Engineer of the U. S. Indian Service, W. H. Code, at present of the firm of Quinton & Code, Wright & Callender Building, Los Angeles, Calif., with the writer in charge in the field. A. L. Darr was assistant engineer in charge of surveys, and Hector Gillis was superintendent of construction.

A Trench Bottom Raised by the Load of Excavated Material on the Banks*

The accompanying views show a four-barrel brick outlet sewer at the foot of Morell St., Detroit, Mich., the completed portion of which was destroyed on Jan. 12 by a slip in the clay subsoil surrounding the unsheathed open trench. The four barrels of the sewer were of circular cross-section, made of two rings of brick, 5 ft. in inside diameter, and the invert was laid 14½ ft. below the street grade. When completed the sewer will extend from Jefferson Ave. to the Detroit River.

The character of the excavation is clearly illustrated in Fig. 1. The material excavated, consisting of about 5 ft. of ash and cinder fill, 2 ft. of clay fill, and the remainder a soft blue-clay subsoil, was thrown into piles about 15 ft. back from the trench opening. The weight of this superimposed material on the saturated clay subsoil caused a slip and consequent upheaval of the bottom of the trench, which destroyed the short section of sewer completed. The upheaval varied from 6 in. to 5 ft.

In Fig. 1, on the left, may be clearly seen a crack

FIG. 2. CRACK IN EXCAVATED MATERIAL SHOWING SETTLEMENT OF 12 TO 15 INCHES

across the face of excavated material marking line of settlement. This settlement amounted to 12 or 15 in., and is more clearly shown in Fig. 2. From Fig. 1 the proximity to the work of the Jefferson Ave. street-railway tracks is apparent, and it is not unlikely that the jar of passing cars contributed materially to cause the slide.

*From data furnished by W. I. Cathcart, 223 Atkinson Ave., Detroit, Mich.

An Electric Tractor for Hauling Freight Cars in City Streets, Pennsylvania, R.R.

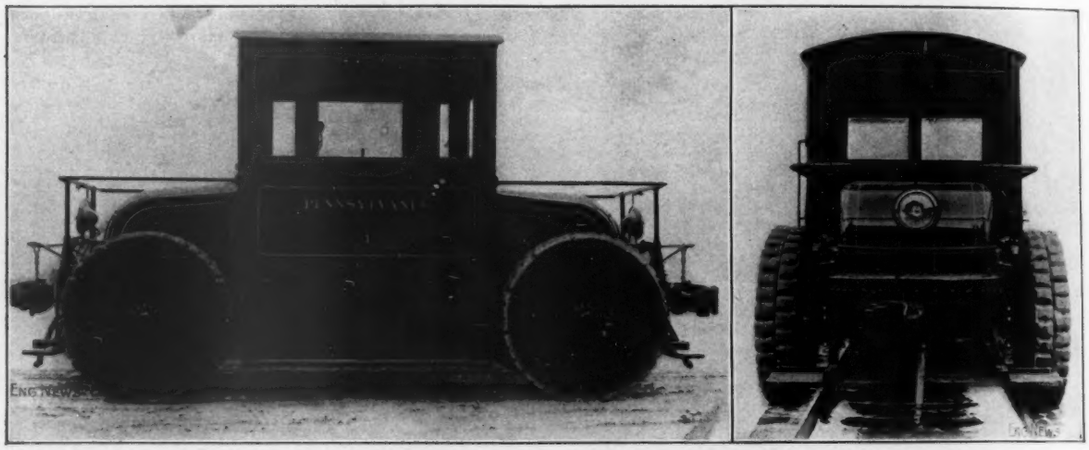
In the accompanying cut is shown a view of the new electric tractor recently built in the Juniata shops of the Pennsylvania R.R. and tried out at Altoona, Penn. The tractor was built as a substitute for long strings of horses which have hitherto been used for freight-car hauling in the city streets, and its construction was undertaken only after extensive trials of commercial trucks and tractors had proved them inadequate for the special service. The principal dimensions of the tractor are as follows:

Length over couplers	23 ft.	Drawbar pull (normal)	8000 lb.
Wheel base	12 ft. 6 in.	Drawbar pull (max.)	21,500 lb.
Width over all	8 ft. 4 in.	Speed (normal)	6 m.p.h.
Weight	28,850 lb	Battery	80 cells Edison A-12-H
Width of tires	12 in.	Weight of battery,	4350 lb.

The most remarkable feature of this tractor is that it drives, steers and brakes, on all four wheels. This development was made necessary on account of the short radius curves around which the tractor would be required to operate and the necessity of driving all four wheels in order to secure the necessary tractive effort. The wheels and driving mechanisms are located near the ends of the chassis and the battery box hangs in the center directly under the cab. The cab contains the air compressor, controlling apparatus, and steering wheel. Sloping hoods at each end of the cab cover the driving mechanisms.

The driving mechanism at each end is supported by the axle, and is held in position by radius rods. The motive power is furnished by two General Electric motors of approximately 20 hp. apiece. Each motor is connected through a set of herringbone gears to a countershaft, the employment of the herringbone gears necessitating the use of a special flexible coupling between the armature shaft and the herringbone pinion. Integral with the countershaft gear is a differential gear of special design, a new departure in differential construction wherein each side of the differential drives a section of the split countershaft and each section of the countershaft carries a universal pinion, which meshes with the driving gear that is bolted to the wheel casting. Through this system of gearing a reduction of about 40 to 1 is obtained. All gears are made of special steel, and heat treated. All rotating parts of the driving mechanism are carried on ball bearings.

The wheels, which are of the tangent-spoke type, are steel castings, weighing approximately 1200 lb. and are equipped with steel-base solid-rubber-block tires of such design that one section may be removed and replaced without disturbing any other section. Each wheel is carried on a steering knuckle, which is operated by a steering arm engaging with another arm on a longitudinal shaft, carried by the chassis. This longitudinal shaft is made in two sections, coupled at the center by means of an interrupted crank. From this coupling there are two connectors, which are attached to a system of planetary gearing driven by a large steering wheel in the center of the cab. This steering wheel is of the marine type and turns the tractor in the direction the top of the wheel is turned.



SIDE AND END VIEWS OF ELECTRIC TRACTOR BUILT BY THE PENNSYLVANIA R.R. FOR HAULING FREIGHT CARS IN CITY STREETS

The four-wheel steering arrangement allows the tractor to turn in a circle of 20 ft. radius, the trailing wheels tracking with the forward wheels. This tracking feature allows the operator to devote his entire attention to the forward end of the tractor, since the trailing end will always clear anything that the front end has cleared.

On each side of the cab there is a lever connected to the controller, and also a motorman's brake valve. The controller lever allows the operator to drive from either side of the steering wheel. The lever is moved in the direction in which the tractor is to go, and a guard prevents the operator from going into reverse without first coming to a full stop. The brake valve controls the operation of the air-brake apparatus. This is of the automatic type, air being supplied to the main reservoir by a motor-driven air compressor. The application of air actuates a system of equalizing levers, which operates the internal expanding brakes carried by the wheels. Standard air-brake hose couplings allow the air to be used on the cars that are being shifted. This automatic air brake is supplemented by a hand brake, which may be used at any time, separately or in conjunction with the air brake.

An application of the brakes is utilized through a lever to bring the controller to the off position, thus making it impossible to use power while the brakes are on.

The normal drawbar pull of the tractor is 8000 lb. During one of the trials in the Juniata shop yard it pulled a locomotive and two cars with such surprising ease that it was decided to have the tractor and the locomotive push against each other to see what the tractor could do. With the throttle wide open, the locomotive failed to hold the tractor and was moved several feet. The locomotive used was a Class "R," rated at 21,500 lb. drawbar pull.

Maintenance Treatment of Smooth Pavements in St. Louis*

By W. L. HEMPELMANN†

Smooth pavements, in this paper, include asphalt, bitulithic and creosoted wood-block. Everyone interested in the maintenance of bituminous pavements is familiar with the asphalt patching gang, the equipment and the manner in which repairs are made. "Cutting out and plugging in" is the most common means of repairing an asphalt or bitulithic pavement. To do this properly and satisfactorily requires careful attention to details. The general procedure is to trim the joint properly paint it, and then tamp or roll the hot asphaltic top mixture into the prepared depression.

Careful examination of a pavement where such patching has been done, will frequently reveal the fact that the joint between the patch and the old pavement has not been sealed, due sometimes to a "dirty joint" but generally to carelessness on the part of the laborer in not painting every part of the exposed edge of the depression. This condition is easily observed when, after a rain, the sun has dried the surface of the pavement, while the patches are definitely outlined by a wet line. Another source of trouble comes from the pushing or displacement of patches because of the material used. The patching material should be as nearly as possible of the same consistency as the old pavement, so that when the summer's sun warms up the pavement the old and the new material may soften to the same degree. The folly of using a new street mix as patching material in an old pavement has been shown frequently.

A temperature variation of from 5 to 10° below zero to 120 or 130° F. in the summer's sun, on the surface of the pavement, presents a complex problem concerning the proper mixture to be used. Under slow-moving heavy loads in the summer, the material is apt to push or creep, bringing about a wavy or undulating condition of the surface, which is very "bumpy" to the automobilist. This condition can frequently be remedied by the use of surface heaters; the bumps or high places are softened and all the burned and soft material is scraped off, leaving a clean surface of the old material. Such burning should be continued until the burned area will require at least 1 in. of added material to restore the pavement to its proper surface and cross-section. It is well to cut a joint at the edge of the burned area (1 in. or 1½ in. deep) so that the edge of the old pavement may serve as a shoulder for the new material. The surface of such burned area should be made as rough as possible with a pick or the point of a hoe, so that the old material may mechanically hold the new material in place. The whole area should be liberally sprayed or sprinkled with an adhesive asphaltic cement, to bring about a better union between the old surface and the new material. This method is economical and when properly done, gives entire satisfaction. Our records show that this method of making repairs, including labor, material, roller and fuel, costs from 50 to 55c. per sq.yd., depending upon the conditions, while straight patching in the ordinary way costs from 75 to 95c. per sq.yd.

Here, again, it is absolutely necessary that the joint between the old and the new pavement be waterproof for the best results. The effect of an imperfect joint, or one not properly sealed, is best seen in the late fall or early spring of each year, when by alternately freezing and thawing, the moisture in the joint tends to entirely separate the patch from the rest of the pavement. Such a joint, once opened up during the winter, will not heal in the summer under traffic, the dust from the surface finding its way into these small crevices and preventing the amalgamation of the two mixtures.

In the case of bituminous mixtures having stone of the larger size this open surface condition (which permits moisture to freeze and thaw in the surface) materially aids in pitting the surface. Steel-tire traffic is much more detrimental on such a wet and open surface, as the steel grinds or crushes the surface rock much more readily. With mixed motor and steel-tired traffic, the suction created by the rapid motion of the motor cars tends to redistribute these fine particles. This can be plainly seen after a heavy shower, when the fine material from the surface can be found at the low point in the grade.

Surface Treatment to Prevent Wear

BITUMINOUS PAVING—Recognizing water as one of the worst enemies to smooth pavements, we have endeavored to waterproof our asphalt and bitulithic pavements by treating the surface. Flush-coating or squeegee-coating the last named pavements has generally been done as a matter of course, to seal the surface. Hand squeegee carts or pressure wagons to evenly distribute the bituminous material with a coating of sand are generally used. In recent years, the economy of flush-coating the bitulithic streets under contract maintenance is evidenced by the fact that a flush-coat gang is one of the regularly equipped maintenance gangs when repairs are begun after the winter. This thin coat on the surface performs a double duty. It tends to waterproof the surface, by filling all the surface voids, and with the sand it forms a thin cushion-coat on the surface, taking the wear off the pavement proper. In other words, we tend to build up the pavement by the judicious application of flush coats, instead of permitting the pavement to wear down under traffic. Under our traffic conditions, such a flush coat wears at least a year. Using tar at 7¼c. per gal., and applying it by means of pressure-wagons, our total flush-coat cost on bitulithic pavements last summer (including tar, sand, teams and labor) was about 2½c. per sq.yd.

In case of asphalt pavements, we applied the same reasoning. We have oiled some of our asphalt pavements and covered them with sand at a cost of about 1c. per sq.yd. for material, covering and applying. For an old pavement it was thought that the oil treatment would help keep out the water and at the same time tend to give new life to the bitumen. This thin cushion-coat on the surface plays an important part in the wear during the winter months, when the chains attached to the driving wheels of automobiles have a pounding effect in passing over the pavement. The thin layer on the surface largely takes care of this added wear.

WOOD-BLOCK PAVING—It has been the practice in St. Louis for the last three years to oil and sand the wood-block thoroughfares. This largely is a treatment for slipperiness, and was evolved gradually. Sand or sharp grit was first spread over the surface of such pavements. Most of the sand was soon found in the gutters, blown to the side by the rapidly moving motor cars and by the wind. The benefit from such a treatment was very short lived. Oiled-sand was then tried, the oil and sand being mixed in asphalt-mixing pans and spread over the surface from wagons. This was slow, expensive and unsatisfactory, since the sand had to be heated and dried to mix with the oil, and when this warm material was hauled to the street the bottom of the load was extremely soggy because of the oil which percolated through the sand and collected near the bottom. Spreading this soggy material uniformly was impossible. At the suggestion of J. C. Travilla, Street Commissioner, the oil was sprayed on the wood-block surface and then covered with sand. This method proved very satisfactory and was economical, costing about 1c. per sq.yd. for oil, sand and labor. For this work we apply about ⅛ gal per sq.yd., using a pressure wagon for distribution. Such a treatment lasts through the winter and largely helps to waterproof the surface.

The Fire Loss on the Pennsylvania R.R. system for 1912, is reported as being the lowest in the 34 years of the road's record, being $219,892, and resulting from 905 fires. The rate of loss is claimed to be very small as the property endangered ran into hundreds of millions. This reduction in loss is attributed to better organization and equipment of the company's fire-fighting forces. In 1908, the road's employees extinguished 274 fires out of a total of 1397 on railroad property. In 1909, the employees put out 321 from 929 total. In 1912, the employees attended to 454 out of 905.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors at Chicago, Jan. 22-24.

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Some Features of the 1913 Motor Truck Show in New York City

The annual exhibition of commercial motor vehicles in New York City, Jan. 20-25, brought out the largest display ever shown, requiring both Madison Square Garden and the Grand Central Palace for its accommodation. No fewer than 26 vehicle exhibitors and 180 exhibitors of accessory supplies were accommodated in the Garden, while 42 vehicle and 44 accessory exhibitors had displays at the Palace.

The number and size of the exhibits emphasize the

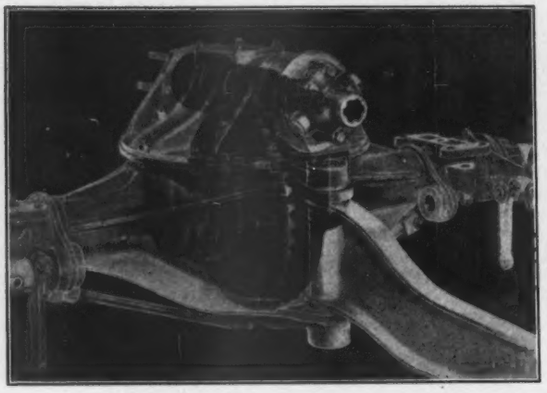


FIG. 1. PHANTOM SKETCH, SHOWING THE WORM-GEAR DRIVE ON PIERCE ARROW TRUCKS

rapid development of this branch of the automobile industry. Rapid advance has been made in motor-truck design during the past year and the vehicles impress one as having had their details much more carefully worked out than was the case a few years ago. Nine out of ten of the trucks, of all types and sizes, are equipped with chain drive, generally outside the chassis frame and exposed. A few makers, however, provide a sheet-metal casing for the chains and run them in an oil bath. Perhaps even a greater percentage of the cars are using double-tread drive wheels, even some of the comparatively light trucks being so equipped. Tires are of all kinds and sizes, but the solid tire seems to have generally won over the pneumatic. The number and variety of dumping-body designs indicates a heavy demand for this type of truck. The four-cylinder vertical motor is nearly universal on gasoline-motor trucks. There was a considerable number of exhibitors of electric trucks, both for heavy hauling and light delivery, and the increasing price of gasoline gives the makers of such vehicles much encouragement.

WORM GEAR VERSUS CHAIN DRIVE—We have noted that the chain drive is nearly universal on motor trucks, but it is interesting to observe that several of the leading manufacturers also show worm-gear drive as a feature of their designs. In Fig. 1 is shown the worm-gear and differential arrangement in use on the Pierce-Arrow truck, and a similar method is employed in driving the Studebaker and the Blair trucks. The claims made for this type of drive are that it gives a large speed reduction in a small space, that it is more durable and efficient than the chain drive, and is free from the wear by dust, grit and sand of the open chain drive. The advantage of noiseless operation, so much emphasized on pleasure cars is, of course, of minor importance on commercial vehicles.

A TELESCOPING DUMPING DEVICE—There is a large variety of dumping mechanisms, running from the davit-crane principle of operation on the Alco to the hydraulic-lift equipment on the Pierce-Arrow and the toggle device on the Locomobile. A telescoping threaded-column arrangement appeared on several trucks, among them the Universal and Packard. The main features of this apparatus as exhibited on the Peerless truck are shown in Fig. 2. It consisted of a threaded rod turning in an internally and externally threaded tube, which in turn worked within a second tube internally threaded. The rod carried a bevel gear at *A*, driven from the engine shaft through a chain-and-sprocket and bevel-gear train. Pivots at *A* and *B* insured alignment of the rod and tube at all times. Raising and lowering were both positive drive and each movement occupied about 30 sec. The mechanism was entirely controlled from the driver's seat.

THE LATIL FRONT DRIVE—Attempts have been made in the past to perfect a rear drive with the motor located on the rear axle, but the Walter Motor Truck Co., of New York City, presented this year an innovation in American practice in the form of a front drive, having the front wheels driven direct from the motor through spur gears. The claims made for this drive are that several types of body can be used with it because the entire driving, steering and control mechanism is a complete unit, detachable, as shown in Fig. 3; that all machinery is both compact and accessible; that a saving in efficiency is obtained by the elimination of drive shafts and transmission gearing; and that skidding is obviated. The points which seem unfavorable to this arrangement are that the steering-gear problem, at no time a simple one, is complicated

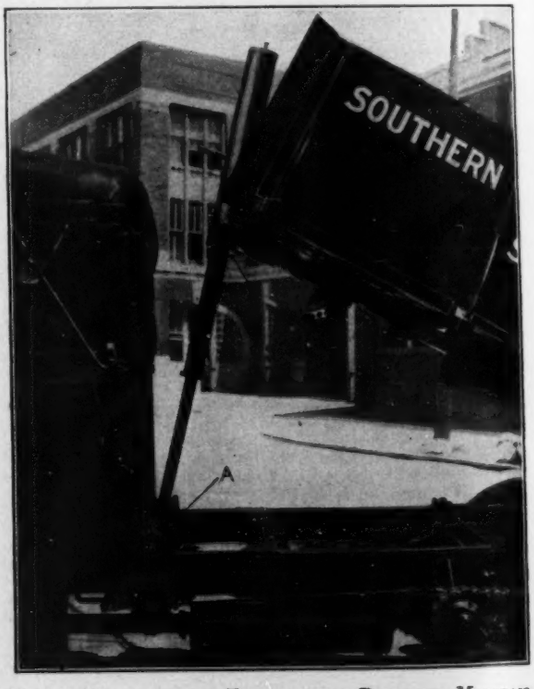


FIG. 2. VIEW OF THE TELESCOPING DUMPING MECHANISM USED ON PEERLESS DUMPING-BODY TRUCKS

by the fact that the front wheels are also drive wheels. What is more important is that the concentrated weight on the rear wheels is not available for traction. Nevertheless the scheme claims eight years of commercial success in French practice and it is not beyond the range of possibility that in level districts, such as occur in many cities of the middle West, the system might be exploited with success.

A Sectional-block Detachable Tire—Although its principles are not entirely new, inasmuch as both sectional-block tires and detachable tires have been extensively used in previous years, the combination of these two ideas in the United States Standard Block and in the Goodyear Individual Block tires is novel and worthy of attention. The advantages of this type are that any single block may be quickly and easily detached and replaced without removing the wheel or disturbing any other block, the only tool required being a small wrench; that tire economy is effected by the ability to replace a section rather than a whole tire; and that tractive efficiency is improved by the sectional nature of the tires and by the staggering of sections.

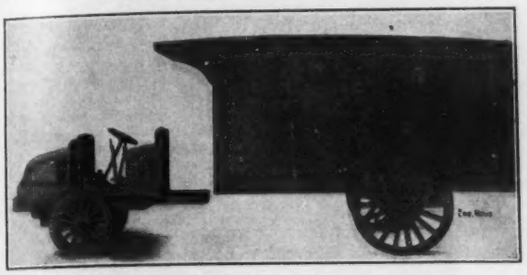


Fig. 3. Side View of the Latil Detachable Front Drive Used on the Walton Trucks

A Three-wheeled Truck—Another of the unusual types at the show was the three-wheeled Knox-Martin tractor, a view of which is given in Fig. 4. An illustration of this truck as used by the Borough Development Co., of Brooklyn, N. Y., appeared in the Jan. 16 issue of Engineering News. This design, like the one above referred to, aims to make use of the present horse-drawn vehicles which may have cheap steel tires, instead of costly rubber tires. The three-wheeled construction also adapts it to uneven roads.

A Motor-generator Starter and Lighter—One of the interesting accessory exhibits was an electric motor-generator starting and lighting arrangement for use on gasoline cars, which possesses several excellent features. The unit is direct-connected to the drive shaft just back of the engine and replaces the usual flywheel. It is in four sections, an aluminum case or frame supporting the field coils and attached to the engine frame, a rotating armature and commutator attached to the drive shaft and revolving in the case and around the field, a brush holder fastened to the case, and a protecting shield of aluminum also attached to the case. The weight of the armature is approximately the same as that of the usual flywheel and, due to the fact that it revolves outside of the field instead of inside as is usually the case, it has been possible to make its diameter and inertia about the same as those of a flywheel of the same weight. For starting, the device becomes a motor driven by the auxiliary storage battery, and for lighting, it serves as a generator, being arranged by means of an automatic regulator, to charge the battery at the required rate. This equipment was on exhibit by the U. S. Light & Heating Co., of New York City.

A Hood Seat—A saving in space on the chassis is obtained in the truck exhibited by the Speedwell Motor Car Co., of Dayton, Ohio, by combining the hood and seat in one piece. With this arrangement it becomes necessary to provide a ready means for getting at the motor, and this is accomplished by tilting the hood seat sideways on hinges, as shown in Fig. 5.

Friction and Hydraulic Drives—Two friction-disk drives were on exhibition at the Palace, the double-disk arrangement on the trucks of the Service Motor Car Co., of Wabash, Ind., and the single disk on the Best trucks, made by the Durant-Dart Carriage Co., Flint, Mich. For the lighter vehicles this system seems to have merit. Another interesting exhibit at the same place was the Manly hydraulic drive on the truck exhibited by the

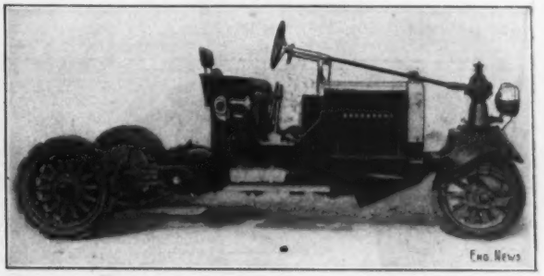


Fig. 4. The Knox-Martin Three-wheeled Truck

Fig. 5. Combined Hood and Seat Arrangement on the Speedwell Trucks

American-La France Fire Engine Co., Elmira, N. Y. The advantages of this are similar to those of the friction drive. Another form of hydraulic drive which accomplishes the same results, was described in the Oct. 31 issue of ENGINEERING NEWS.

OPPOSED TYPE MOTORS—Two-cylinder motors of the opposed type were shown in the Autocar and International Commercial trucks. This design, which was popular a few years ago, has now been very generally discarded in favor of the four-cylinder vertical type of motor.

SPRING WHEELS—An interesting form of flexible wheel was exhibited by the Seaton Wheel Co., of Nashville, Tenn. By the use of these wheels the riding qualities of the pneumatic tire are approximated in connection with the economy of the solid tire.

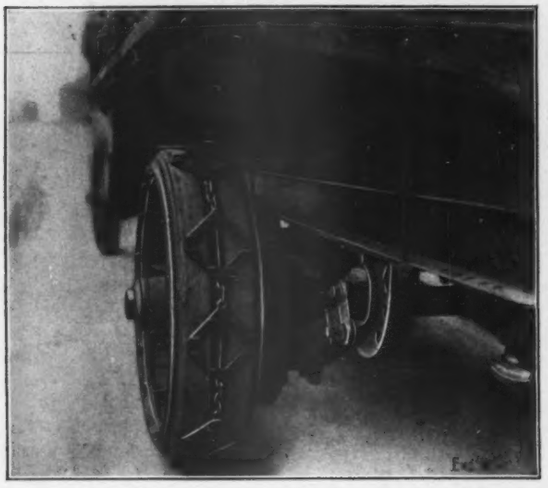


FIG. 6. A NON-SKIDDING ATTACHMENT FOR DUAL TIRES

A NON-SKIDDING ATTACHMENT—For use on double rubber tires, the device, made by the Eureka Non-Skid Mfg. Co., of Brooklyn, N. Y., and shown in Fig. 6, looked effective. Each of the plates presents eight contact points to the road surface aside from those offered by the connecting links.

STEEL WHEELS—Steel cast wheels, in which rim, spokes and hub are in one piece, were on exhibition by the Johnson Steel Wheels Corporation, of Boston, Mass., which claimed for them greater simplicity, increased strength and, for heavy trucks, decreased weight, over the standard wooden wheel.

A MOTOR "SPEEDER"—A device was shown by the Fudge Bros. Mfg. Co., of Marion, Ind., for improving the working of a motor, particularly in cold weather, by forcing a current of warm air into the intake pipe, proportional in volume to the amount of gasoline used. The air is warmed by being drawn through a coil around the exhaust pipe.

A List of Testing Laboratories is to be compiled by the new Austrian government "Technische Versuchsamt" (Michelbeuerngasse 6, Vienna). Private and public testing laboratories throughout the world are hereby asked to send the "Versuchsamt" all pertinent information concerning their field of work, organization, commercial or educational affiliation, equipment, and extent of operations. Wm. Exner, k. u. k Wirklicher Geheimer Rat, is president of the "Versuchsamt."

Topographical Surveys for Drainage Districts*

By WALTER A. BIRKET†

Topographic surveys in connection with the reclamation of swamp and overflowed lands along the Mississippi and Illinois rivers are made for the following purposes: 1, the location of levees and main and lateral ditches, and the preparation of estimates of cost; 2, the assessment of benefits and damages.

For the location of the levee, detail topography should be taken along the river extending back 600 to 1000 ft. In most cases a ridge of higher land is found near the river, and sometimes the levee location can follow this the entire length of the river front. More often it approaches too near to or recedes too far from the river bank, and then it becomes necessary to cross to another ridge. The question then arises as to where the location should leave the ridge and where the crossing can best be made. If there are other ridges further from the river that appear to be higher, it is necessary to extend the topography to cover them, as the question will likely arise whether the additional land taken in by the location nearer the river will pay for the additional expense of building the higher or longer levee which would be necessary? With all the possible locations made on a topographical map, and the cost of each route estimated, it becomes a simple matter to choose the best route.

For the location of main and lateral drains, it is essential to know the elevation of all sloughs, ponds or other depressions in order that a ditch can be located and a grade established that will drain such places. It is also necessary to have the elevations along the line of the ditch so that an estimate of cost can be prepared, as it is seldom possible to make the best location (without the aid of a topographical map) except by running out several locations, and even then the best location is not always found. From a topographic map, with contours of 1 ft. intervals, it is a small matter to make an estimate on all possible locations, from which the most desirable route can be adopted. For the assessment of benefits, it is essential to know the elevation and extent of all ridges and depressions. The most practicable way to show these features is on a topographic map, with 1-ft. contours. It is also important to know the amount of timber, that part of the land which is prairie and that which is cultivated, and to be able to tell from the maps the amount of land in each tract that will not be reclaimed, if any.

Methods of Survey

The methods used in 1912 on a survey of 20,000 acres are described below. The levee had been constructed a number of years, so that the extra detail necessary for levee location was not required. The information necessary was for the assessment of benefits, the location of the interior drainage ditches, and the diversion of hill streams. The territory covered ranged from two to four miles wide, extending from the river levee to the bluffs, and about 12 miles north and south. A camp was established, with three 14x24-ft. tents. One tent was used for kitchen and dining, one for quartering the rodmen, and the third for the topographers, instrumentmen and draftsmen. The last was used also as the field office where the plotting was done.

There were two topography crews, each consisting of a topographer, an instrument man and three rodmen. A third crew (instrumentman and two rodmen) was organized to run base line. When this crew had finished all the base line that could be run from a given camp, it was disorganized, one rodman being put in each of the topography crews, while the instrumentman worked in the office computing and assisting the draftsman. The base line was run from north to south through the center of the district, using the regular stadia methods, except that no topography was taken. Azimuth was carried and checked by deflections right or left from the last line produced. The elevation of stations was carried by differences of elevation, as follows: The height of the telescope above the stakes was determined with a rod graduated in feet and tenths, or by bringing the point of the plumb bob to the top of the stakes, then swinging it over to a graduated leg of the instrument. The difference between the height of the instrument and the rod read on a station when the telescope is level is the difference of elevations of the two stations. As this difference is taken both forward and back from each station it furnishes a check on

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, held at Chicago, Jan. 22-24.

†Harman Engineering Co., Peoria, Ill.

the work before leaving the station. The average of the two differences is used for the difference of elevation between the stations. No vertical angles were used between stations, and only on side shots when the rod could not be used direct.

The elevations of the base line stations were checked by direct levels with fore and back sights of 300 ft., as nearly as practicable. The distances along the base line were read by stadia and checked by chaining. The chained distances and direct levels were used as correct, in preference to the results obtained by the stadia and difference of elevation methods, providing they did not differ more than could be expected from the different methods used. Where the error was greater than allowable a second check was run. The method gave a base line in which there was little chance of errors, and in which none were found.

The two topography crews were started east and west from the base line. Each ran to the limits of the district (the levee on the west and the bluff on the east), then north half a mile and then back to the base line, making a circuit of about 4½ miles. These circuits were closed on the base line for azimuth and elevation. A tabulation of the circuit was made in which the error in azimuth and elevation was prorated throughout the circuit. This tabulation also included a traverse of the circuit, which was prorated to close. As the error in azimuth was prorated before the traverse was computed, the error in traverse was considered as due to errors in distance and was prorated on that basis. The error in departure was prorated in the east and west lines, and the error in latitude in the lines north and south.

The first lines east and west from the base line were run along a section line and the return lines along a quarter-section line, half a mile from the first line. The next lines were run along a section line one mile north of the first line to the limits of the district, then south half a mile to close on the first circuit. Errors in azimuth, elevation and traverse were corrected and prorated to the correct results for the station tied into. The circuits were run in this manner between the base line and the limits of the district along each section and quarter-section line, and closed on the base line and on the preceding circuit at the limits of the district alternately. This gave a base line north and south about the center of the district, which was checked and free from observable errors; also stadia lines east and west across the district at half-mile intervals, each one being closed back to the preceding circuit at the limits of the district, thus avoiding all chance of small errors accumulating. The allowable errors were 5 min. in azimuth and 0.2 ft. in elevation. We found no trouble in keeping within these limits.

Stadia Work

In open country the circuits were run along the section and quarter-section lines and a distance of a quarter-mile used between stadia stations. This was in order that a station would be near each 40-acre corner, making it possible for the topographer or instrument-man to make a search for monuments. Rodmen do not realize the importance of tying in monuments and, as a rule, make little if any search for them. Anyone who has sectionized a topographic may of a large area realizes that even if all the information available is plotted, such as monuments and fences, there is little enough from which to correctly plot the section lines. As the areas of fractional tracts within the district are computed to these lines as plotted, and ditch lines are located along them, it is very important to obtain all the information possible that will in any way influence the plotting of the section lines. It is time well spent to keep the work well squared up in such a way that an instrument station is near each 40-acre corner.

In timber it is seldom possible to get stations one-quarter mile apart. Sometimes half this distance can be taken and it will give the same results. Where even this is not practicable, if the stadia line is kept near the section or quarter-section line, the instrumentman in passing from one station to the next will pass the corners and can make a search for monuments. In timber country, or where there is a great deal of detail to be taken, it is not possible to cover the ground from lines half a mile apart. Then it is necessary to set spur stations from the main circuit from which to get the detail. To save the time necessary to set off a spur station, if the instrument is set up at a point from which the detail can be got, and oriented by means of the compass; the azimuth, distance and difference of elevation back to a station on the main circuit are read, and the detail then taken in the usual way. By using this method the instrumentman is able to pick the position from which the detail can be taken with the least amount of work. For spur stations, the location must be left to the rodman, or a special inspection made by the topographer. Results obtained by this method are as accurate as ordinary stadia or spur stations, but would not be if circuits were run by such methods as would permit errors to accumulate. By closing the circuits by traverse, using a chart from which the latitude and departure of each line was read, time is saved and the results are much better, as the errors can be prorated more nearly in their proper places than can be done by plotting. The errors found are errors in the circuits themselves and do not contain errors of plotting. By plotting the circuits by traverse there can be no accumulation of errors.

Sketching

Instead of sketching the work in the field book, as is common in topographic work, sketch sheets 8½x11 in. were used on a board which would take four of these sheets at one time. The board was rounded out to fit a man at the waist, and had a strap from the outside corners passing over the shoulders. This enabled the topographer to work on the board while standing, and also to compare the sketches with the territory while walking over it. The observations taken by the instrument man were recorded in a field-book and also plotted with a half-circle stadia protractor on the sketch sheets by the topographer. The sketches were made to a scale of 1 in. to 400 ft. (the same as the finished drawings). With the shots plotted on the sketch sheets in the field, it is possible to sketch a great deal of the work which would have to be taken by shots if less reliable sketches were used. Enough contours were drawn on the sketches so that they could be used as a guide for the finished maps.

When it is difficult to get the shots, the topographer is able to keep the elevations computed and plotted as fast as they are taken. When the work is done easily the topographer will not be able to keep up. In that case, when the station is worked out, it is necessary to stop and plot the shots before the instrument is moved to the next station. This takes but little time, and as soon as the work is plotted the instrumentman takes the book, goes to the next station and starts work. The topographer in going to the next station covers the territory between the circuit being run and the last preceding circuit, sketching the sloughs and swales that are not shown by actual shots, as it is not practicable to take shots at all the crooks and turns. If the topographer works between the line that is being run and the last preceding line, he is able to cover the territory well and keep the sketch up without delaying the instrumentman. The latter will be delayed by having to keep his own notes while the topographer is sketching, but this will be more than offset by the number of shots that will be saved by the sketch method, besides obtaining much more reliable work.

The advantages of this method are : 1, the work is plotted in the field, the sloughs and swales are followed out and are connected up properly; 2, the work is plotted from the balanced notes; 3, a draftsman who has never seen the territory can finish up the maps from notes and sketches and contour them correctly. The advantage over the plane-table is that the transit sets higher and therefore overlooks a great deal of vegetation that would have to be cut if a plane-table were used. Work can be done more rapidly with a transit than with a plane-table. With the sketch method it is not necessary to take more than 75% of the shots that would be necessary with the ordinary stadia method. Sometimes with the latter method the territory is not covered and sometimes it is covered twice, due to the instrumentman not being able always to tell the distance between the line he is running and the preceding line, when one or both lines are not straight, on account of timber and the necessity of running an irregular line in order to get the detail. With the sketch method, the topographer is able to tell at all times just how closely the territory is covered, and he can always scale from the nearest known property corner and tell where to look for the next one.

Cost

The cost of such a survey as described will vary with the local conditions and the time of year. A district with little timber or brush surveyed under ordinary weather conditions should be finished ready for tracing for from 12c. to 14c. per acre. A district with 50% of the territory covered with timber and brush, if surveyed under ordinary weather conditions, would cost from 14 to 17c. per acre, while for the same territory surveyed under adverse conditions the cost might run as high as 20c. per acre.

A Federal Income Tax is made possible by the sixteenth amendment to the United States Constitution, ratified by the state of Wyoming, Feb. 3. This ratification completed the necessary three-fourths of the States.

A Problem in Beach Reclamation and a Prize for its Solution

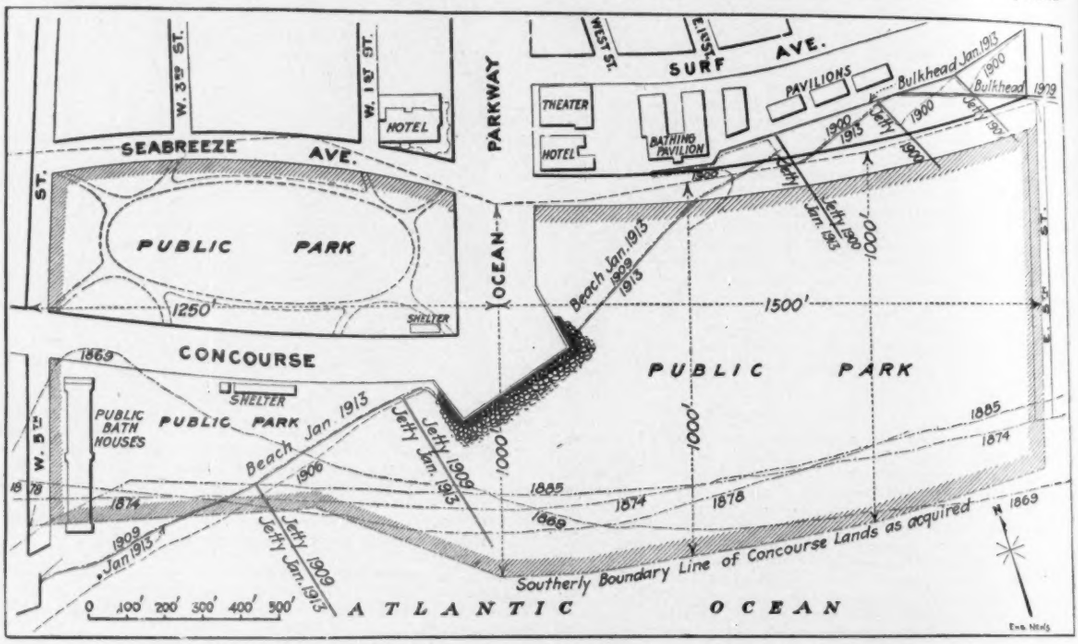
The accompanying plan shows a part of the famous Coney Island shore, in the Borough of Brooklyn, New York City. It is the only part of several miles of waterfront facing the open Atlantic Ocean and frequented by hundreds of thousands of people every summer, which is now the property of the city and is accessible to everyone. Located at the end of Ocean Parkway, one of the most popular automobile roadways in Greater New York, it is one of the most frequented parks in the city, during the hot weather, by all classes of people.

The plan shows the line of the beach between the years 1869 and 1912. By the unchecked natural process of coast erosion, the city has allowed about half of the beach to become washed away and submerged.

Through the generosity of Alfred T. White, of Brooklyn, N. Y., the Brooklyn Engineers' Club is enabled to offer prizes of $200 for the best plans for reclaiming this beach. While there is, of course, no assurance that the beach will be reclaimed, the problem itself will interest many engineers and perhaps lead them to study a phase of engineering work not often met with by the ordinary engineer, yet in many countries, notably in Holland and parts of England, a very important branch of engineering practice. All engineers are eligible to compete.

The end aimed at by the competition is to obtain the best possible suggestions for the restoration of the beach on its original lines within a reasonable time and in a manner to secure the greatest benefit to the public for the least expenditure by the city.

The committee to award the prizes consists of two engineers and one layman; the layman appointed by the Chairman of the Brooklyn Committee on City Plan, one of the engineers designated by the Chief Engineer of the Board of Estimate and Apportionment of the City of New York and one by the President of the Brooklyn Engineers' Club. The committee appointed is: Edward M. Bassett, chairman; William T. Donnelly, consulting engineer, of New York, and William G. Fortune, consulting engineer, of Brooklyn, N. Y.



PLAN OF WATERFRONT BELONGING TO CITY OF NEW YORK AT CONEY ISLAND
(Showing shoreline 1869-1912. Sand beaches extend east and west each side of this property).

PRIZES OFFERED AND RULES TO GOVERN THE COMPETITION

(1) This contest is open to all engineers, whether they are members of the Brooklyn Engineers' Club or not.

(2) The prizes offered are as follows: First prize, $150; second prize, $50.

(3) Engineers desiring to compete for these prizes may notify this Committee in writing at the Brooklyn Engineers' Club, in which case they will be furnished with a printed copy of the rules governing the contest, together with a map showing the location and limits of the property under consideration.

(4) For the purpose of this award, the boundaries of the property in question, as shown on the accompanying map, are to be considered, irrespective of any legal question as to the title thereof.

(5) All competitors must submit a map of the property prepared to a scale of 100 ft. to the inch and such other detailed plans as are necessary in connection with specifications to clearly indicate and describe the method and construction proposed for the work, together with an estimate of its cost.

(6) The Committee will consider the relative merits of the plans according to the following general outline:

Permanence of construction.
Economy of cost.
Time required to effect the result.
Largest public use and benefit.
Completeness of the plans as shown by description, specifications or drawings.
Justifiability of the plans as shown by experience.

(7) All specifications and plans submitted to the Committee must be signed with a nom de plume and so as not to disclose the identity of the party submitting same, and this signature, together with the proper name of the engineer, must be inclosed in a sealed opaque envelope, superscribed with the same nom de plume on the outside of such envelope, to be delivered at the same time.

(8) The plans and specifications will be received and retained by the Committee for the purpose of award only, it being understood that they are to remain the property of the engineer submitting same.

(9) It is to be further understood that the Committee will exercise no authority and will have no influence relative to the use of any of the plans for the actual reclamation of the property referred to, by the city.

(10) All plans and specifications submitted for this contest must be in the hands of the Committee on or before May 15, 1913.

(11) The Committee of Award will report its findings to the Brooklyn Engineers' Club, on or before June 15, 1913.
(12) The plans and specifications which are awarded first and second prizes will be published in the "Proceedings" of the Brooklyn Engineers' Club, and honorable mention will be made of such others as are deemed to have special merit.

Railway Bridges on Track Elevation*

By Geo. H. Tinker†

NOISE—Some of the early bridges on track-elevation work, which carry trains over the streets, are objectionable on account of being quite noisy. At the Clifton Boulevard bridge, the rails rest directly upon the floor plate, held down by clips, and trains produce a roaring sound which can be heard for a long distance. In determining how this noise could be reduced, bridges of various types in different cities have been observed. In Pittsburgh, two bridges carry the Pennsylvania R.R., across Penn Ave. and 10th St., and it is remarkable how little noise is caused by trains crossing them. On both bridges there is a deep bed of ballast. In Chicago there are a number of bridges which apparently are of similar construction and yet the noise is quite pronounced. Probably there is not very much ballast. There is also much noise produced by street cars passing under the bridges. Where the beams of the floor are exposed beneath the bridge, and form air pockets, the passage of the car sets up a reverberation. Where the floor is heavy and there is considerable concrete, the noise is much less. Observations seem to indicate that if a bridge is constructed with a considerable depth of ballast the vibration of the rails and the parts of the bridge will be reduced. And further, that if a smooth under-surface of the bridge is obtained there will be very little opportunity for reverberation in the subway.

WATERPROOFING BRIDGE FLOORS—The dripping of water through the bridge floor upon the street is objectionable even when the amount of water passing is quite small, because the water collects lime, grease and rust, which, dripping upon passers-by, may ruin their clothes Therefore, it has become necessary, and is required by ordinance in some cases, that bridge floors should be waterproof. The accepted method of waterproofing a concrete slab in a bridge floor is to place upon it a ½-in. to 2-in. layer of some of the asphalt, coal-tar or petroleum-product gums, with which may or may not be included several layers of burlap or felt paper. A small surface covered with these substances will hold water indefinitely, but when spread over a large expanse of bridge floor, there are other difficulties to be met, and the greatest of these is the expansion and contraction from temperature. Asphalt itself, if its condition remains unchanged, is quite impervious to water, but if it contracts through cold, and cracks, the water will pass through the crack. It takes a very small crack to produce a leak which is objectionable in a bridge floor, and therefore it is necessary to have a substance which will expand and contract with the slab and not crack. This leads to the other extreme, that is, a substance so soft that when it becomes warm it will run. There are bridge floors in Chicago which leak asphalt.

Several substances are on the market for incorporation with the sand and cement to make impervious concrete. The theory is that they make the concrete so dense that water cannot percolate. Extravagant claims are made for some of these materials. A well-built slab of concrete is fully as impervious as a poorly-built slab with any style of waterproofing. The asphalt, coal-tar or petroleum-products used require protection against abrasion and damage from external causes. This requires a still greater thickness. Many bridge floors with a protection of brick on top of the asphalt have been fairly successful from a waterproofing standpoint, but the finished waterproofing adds about 6 in. additional thickness to the bridge floor, and it is thought that this could be better utilized by placing 6 in. of concrete on the floor.

In the bridges recently built in Cleveland by the N. Y., C. & St. L. R.R., no foreign waterproofing substance has been used. An attempt has been made to construct a concrete slab, which would be in itself as nearly waterproof as practicable. This has proved satisfactory. When the Cedar Ave. bridge floor was built, the ends of the bridge were dammed up, the trough so formed was filled with water and allowed to stand for several days. No water whatever came through at any point of the slab.

For successful waterproofing of the floor it is necessary to get rid of the water, which means that a drainage system must be provided of ample capacity to take care of all water that can collect upon the floor. This is a difficult matter, as the drainage system has to be carried some distance, to make a number of angles or bends, and eventually to reach the street gutter or sewer. The essential points in constructing a watertight floor slab are: 1, dense concrete (the denser the more impervious); 2, intelligent study and design in the location of expansion joints; 3, the provision of an ample drainage system; 4, careful workmanship and constant supervision during construction.

LOCOMOTIVES UNDER BRIDGES—With bridges over the tracks where the clearance is low, the blast from the engine has a very detrimental effect on the structure. In Chicago, it has been determined that where the clearance is about 18 ft., the steel will be worn away by the blast at the rate of about ¼ in. in ten years. That means that the flange of an I-beam would be so deteriorated in ten years that the beam would have to be replaced.

At the Detroit Ave. crossing of the N. Y., C. & St. L. R.R., the clearance is 16 ft. 3 in., which is the general rule in Cleveland. The I-beams are covered with concrete to a thickness of 1½ to 2 in.; it was found in the course of a few years that the engine blast eroded the concrete, so that in about five years there is a bare streak of steel over the center of the track. At the Adelbert Road and Cornell Road bridges it was decided to place cast-iron plates immediately over the center of the track. These plates are about ½ in. thick. The engine blast will not be as destructive as upon steel, and when the plates are destroyed they can be replaced with little trouble and expense. In Philadelphia, the Philadelphia & Reading R.R. placed a wooden ceiling under the steel bridges; this gave fair satisfaction for several years.

Our experience is that a concrete covering will be satisfactory for a few years, but where the head room is low (as is apt to be the case in cities) it will not protect the steel permanently. It must then be replaced, and to repair an old, worn surface of concrete is likely to prove a difficult and costly operation.

THICKNESS OF FLOOR—In some cities, there has been a tendency to design the work of grade elimination at the least possible expense. That means the lowest height for retaining walls, the least distance between the street and rail level, and the least thickness for bridge floors. This is unfortunate. While it is true that a bridge floor may be built quite thin, it is not satisfactory and leads to objectionable designs. Wherever the bridge floor consists of simply I-beams and steel plate, which is about as thin as a bridge floor can be made, there will be noise and leakage. In order to reduce both leakage and noise to a minimum, it is necessary to have a reasonably thick bridge floor. In recent designs in Cleveland about 4 to 4½ ft. has been adopted. With this thickness a very satisfactory floor can be made, and it is believed that the additional expense due to the increased height and length of approaches is offset by the greater length of the life of the structure, and by the greater satisfaction which it gives in use.

*Abstract of a paper in the Journal of the Cleveland Engineering Society, Cleveland, Ohio, November, 1912.

†Bridge Engineer, N. Y., C. & St. L. R.R., Cleveland, Ohio.

Massachusetts Laws pertaining to the manufacture, distribution, and sale of gas and electricity and to incorporations engaged therein, have been studied for revision, consolidation, and rearrangement by the Gas and Electric Light Commissioners in conformance with an order of the Massachusetts Legislature of 1912. Their report, recently made, recommends the regulation of transmission companies as well as those distributing and selling power. The recommended codification would cover (1) formation, internal government, and relation of corporations to stockholders and creditors; (2) acquisition, financing and management of municipal plants; (3) use of streets for distribution; (4) public supervision and regulation of business of supply.

Among the special recommendations is one that, where a municipality acquires a previously existing private plant, cases of arbitration be referred to the reporting Commission rather than to a special commission. It is recommended that the law provide that a combined gas and electric company or a combination of either with a transmission company cannot be organized without the approval of this Board and after public hearing. The present statute prohibiting the consolidation of gas and electric-light companies, except to a limited extent, is held to be desirable. The report seems to recommend the granting of rights of eminent domain to high-tension transmission concerns. The Commissioners show how they have permitted the entrance of transmission companies into areas already supplied by local generating and distributing companies; this action is reported to have been stimulating to the service of local companies, and the terms imposed have prevented indiscriminate and wasteful competition.

Explosion-Proof Electric Equipment for Mining Service

The need for safe electric motors in mining is particularly felt in the coal regions where the presence of combustible gases and explosive mixtures is always a possibility. It is evident that if such apparatus is not in absolutely gas-tight cases and happen to be working in a combustible atmosphere, then there will be an accumulation of explosive mixtures in the cases to be ignited by any chance spark. A number of investigations of devices for rendering electric motors and switches safe for use in gaseous mines have been brought to a completion recently and the results are now available.

U. S. Bureau of Mines Investigations*

This series of studies was undertaken as one line in a more general series leading to the ascertaining of methods for lessening risks in the use of electricity in mining. A circular letter was sent to manufacturers of electric motors for mine service, stating that the Bureau proposed to make tests for motors designed for operation in the presence of methane. Five motors were submitted for test as a result, no two being protected in exactly the same manner. In conducting the experimental work on these motors an effort was made to produce conditions that would introduce the greatest elements of failure: (1) in each case some way was developed of producing sparking sufficient to ignite gas; (2) the motor casing was completely filled with explosive mixture; (3) the motor casing was surrounded with similar mixture.

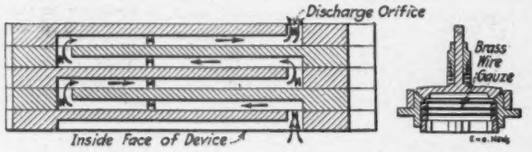


Fig. 1. Safety Devices for Electric Motors, Tested by U. S. Bureau of Mines; Types C and A

Several factors were controlled to suit the desired conditions; (1) ratio of gas to air in mixtures, (2) ignition point within the motor casing, (3) presence of coal dust within the motor casing. No effort was made to control the temperature of the mixtures outside the motor.

Four classes of protective attachments were shown in the sample motors submitted. The motors were all of a closed type, and the devices acted on the principle of the Davy safety lamp, in reducing the temperature of the products of internal explosion to such a point that they would not ignite the mixtures outside.

The first device ("Type A") consisted of three layers of gauze protected by a poppet valve. The motor used for testing was equipped with two such devices, one for each side of the casing at the commutator.

The second device ("Type B") consisted of two unprotected layers of gauze having an exposed area of approximately 4x5½ in. The motor submitted was provided with two such devices, one for each side of the casing covering the commutator.

The third scheme ("Type C") comprised five baffle-plates, so arranged to give a tortuous path for the products of explosion. The area of cross-section of the gas path was 1 sq.in. and the openings into and out of this were 1½ sq.in.

The fourth type ("D") consisted of two sets of plates, one of which was located at each end of the motor casing. Each contained 43 plates of sheet iron, 1/25 in. (1 mm.) in thickness and spaced 1/25 in. (1 mm.) apart by small pieces of the same material as the plates. These plates were in the shape of flat rings having an inside diameter of 11.4 in. (30 cm.) and an outside diameter of 15.7 in. (40 cm.). The total relief area of each set, at the inside edges of the plates, is 24 sq.in. and 34 sq.in. at the outside edges.

The fifth type of device ("E") consisted of two sets of gauze and baffle-plates, one of which was placed at each side of the motor casing at the commutator end. Each set consisted of five sheets of 30-mesh brass gauze, 4½x6 in., separated a distance of ¼ in. by bronze spacers, in each of which were 16 holes, 1½x1¾ in. These plates were inclosed in a bronze cover having a double baffle-plate at the outlet, and the whole was bolted to the motor casing by capscrews.

The device with unprotected gauze ("Type B") was rejected without test. Some weak point was shown in each device. In only four tests out of 191 did the first type of device prevent the passage of flames. Although few actual explosions resulted in the outside explosive mixtures, the margin of safety seemed too narrow; the successful operation of this type appeared to depend on the cooling of the expelled gases outside rather than within the device. The margin of safety was overstepped when the maximum heat was discharged at a comparatively low pressure, as when the gaseous mixture within the casing was exploded with the poppet valve open, a condition which might exist in practice to help the cooling of the motor. The third type was given a few tests because it was of rugged mechanical design, although failure was almost a certainty. The openings in the baffle-plates were so large that their cooling effect was negligible, and flames could easily pass. With gas in the motor casing, the space between the baffle-plates was also filled with the mixture, and the transmission of flame throughout the entire length of the passage between baffle-plates was helped.

The armature of the motor protected by the device of the fourth type carried a fan so as to cause a considerable circulation of air through the motor casing when the armature was revolved at high speed. Flames were discharged through the protective device in all tests in which the motor was running with the fan in place, but no outside flames were observed in any other test. Flames appeared at the inside edges of the plates from the burning of a fiery mixture not within the casing at the time of the explosion, but drawn by the fan. The failure of this type was due more to the severe conditions imposed by the motor's design than to imperfections in the device itself. It was considered impossible to build a device of reasonable size that would absorb the amount of heat produced by continuous operation (and after-burning) in a gaseous atmosphere.

With the fifth type of device no "punctures" occurred with gas alone, except in one test with one of the devices out of service, but it failed in tests where coal dust was sifted into the motor casing and the gas caused to explode inside. No flames issued through the protective

*See Bulletin 46, U. S. Bureau of Mines, Washington, D. C.

devices, but the coal dust was driven out and the explosion seemed to start from a point within this cloud after its expulsion. It indicates that probably the dust was raised to ignition temperature before it left the casing and on reaching the outer air burst into flame. The weak point of this type was considered to be the tendency to ignite coal dust, deposited in the openings of the baffle-plates outside the gauzes.

Concerning the design of true explosion-proof protective devices, H. H. Clark, of the U. S. Bureau of Mines, concludes the pamphlet as follows:

Explosion-proof protective devices should be so designed that flames cannot be driven through them by an explosion of gas within the casing of the motor to which they are connected. They should also be so designed that coal dust cannot enter them or, if allowed to enter, cannot be discharged while ignited. Such devices should be very rugged in mechanical design or they should be completely protected from injury. They should also be so constructed and applied to the motor that they cannot be detached from it without rendering the motor inoperative.

The casings of explosion-proof motors should be designed with the fewest possible number of openings. An ideal casing for this purpose would be one that had no openings whatever except those to which the protective devices were attached. The electrical conductors which enter such casings should be efficiently bushed with hard fiber or some other material that will make a strong and tight joint. If the amount of unoccupied space within the casing is made as small as possible the duty of the protective devices will be reduced to a minimum.

The factory tests to discover unprotected openings in the casings of explosion-proof motors should be as rigid and complete as any tests made upon the protective devices themselves. Several incidents that occurred during this investigation emphasized the importance of making such tests for tightness.

The most satisfactory form of protective device is one that is capable of absorbing a large amount of heat. In order to do this the device must be constructed of a metal that is a good conductor of heat. A considerable amount of metal should be used and it should be so disposed as to offer a large amount of heat-absorbing surface to the flames without being itself raised to an unsafe temperature. The total area of protected openings through the wall of the motor casing should be as large as is consistent mechanically. There are two reasons for this arrangement. First, it permits the use of more heat-absorbing material, and, second, it decreases the maximum pressure developed. The lower the pressure, the lower the temperature of the flame and the less heat is passed through the cooling devices in a given time. With a lower pressure the rate of flame propagation is slower; consequently, heat absorption is facilitated.

Use may be made of the fact that the advancing edge of the explosive wave is the most likely to be chilled because it passes through the coolest metal. If, then, the relatively cool dead gas produced by this means is passed through a comparatively long passage, like that between the baffle plates of the type E devices, subsequent flames will be cloaked with noncombustible gas and can cause no ignition.

Finally, the simpler and more rugged the design of such devices the better are they adapted for practical purposes. The devices should be so mounted as to render impossible the separation of plates or the rupture of gauzes. A splendid place for such devices would be entirely within the motor casing, with vent holes for the escaping gases.

Work of the Allgemeine Elektricitets Gesellschaft

In the *A. E. G. Journal*, for December, 1912, is the abstract of a lecture by Bergassessor Lisse, of Kattowitz, on the occasion of the "Allgemeiner Bergmannstag" 1912, describing work in Europe. He states that two fundamental systems have been followed, one culminating in the principle of installing the electric motors and apparatus at such points in fiery mines as are free from firedamp, while the other consists in developing motors and apparatus with an explosion-proof frame. The first system, he says, has been adopted chiefly by mine owners and particularly in Austria, where in the Karwin district large pumping motors have been erected, protecting, not the motor, but the pump chamber against the entrance of firedamp. The chamber was made airtight from the water hole, while the connection with a crosscut is provided with three iron doors, the two outer ones of which open in an opposite direction to the inner one. Endeavors have been made wherever possible to withdraw the winch motors from the firedamp sections of the mine by placing them in a current of fresh air. In the Courle mine, near Carmen, the hoisting winches are placed at the lower end close to the opening of shafts, which are 94 ft. (120 m.) high in places.

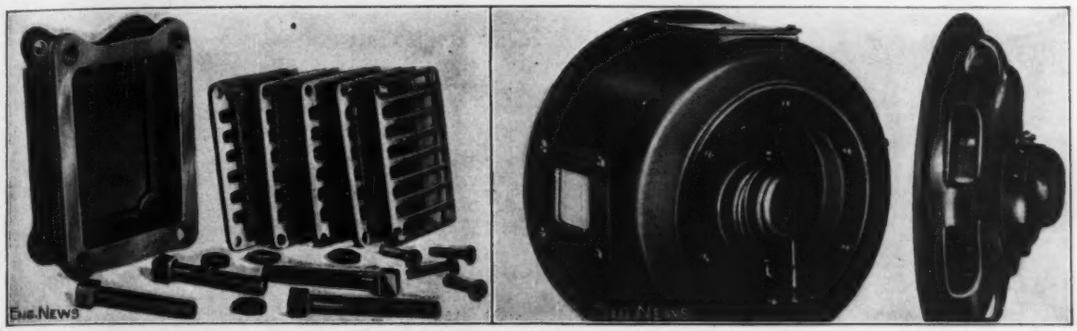


Fig. 2. Safety Devices for Mine Motors, Tested by the U. S. Bureau of Mines; Types E and D

Fundamental experiments for the development of explosions through motors and apparatus were carried out on the Gelsenkirchen-Bismarck experimental section.* These tests showed that three forms of construction were preferable in designing motors, transformers, starting apparatus and switch gears; (1) total inclosure, (2) laminated plates, (3) oil protection.

The totally inclosed type assumes a construction of casing that can withstand the pressure of explosion in event of ignition of firedamp mixtures inside. The

*"Tests For Determining Explosion-proof Qualities of Protected Motors," Bergassessor Beyling, "Gluckauf," 1906, Nos. 1 to 13; "Testing and Valuation of Protective Devices for Electric Apparatus," Dipl. Ing. Goetze, "Elektrotechnische Zeitschrift," 1906, p. 4; "Experiments with Fire-Damp and Protection of Electric Installations," Hoffman, "Zeitschrift Des Vereins Deutscher Ingenieure," Mar. 23, 1906, No. 12, p. 43.

second type follows the principle of the Davy lamp. In the third type, a convenient form of construction can be adopted for controlling switches and auxiliary apparatus, but with motors it is employed, as a rule, solely for the protection of slip rings. In the switches, the opening and closing of circuits is done under oil.

It is found that the plate-protection parts must be very carefully manufactured, as the effectiveness is completely destroyed by a single fault, such as one gap which is too large, or a hidden defect in the frame casting. It is found advisable to subject the finished motor to very careful testing before delivery.

Controllers are made for starting and reversing three-phase motors and up to 5000 volts, particularly for driving winches, pumps and rope railways underground. The contacts lie under oil contained in a tank which may be lowered for inspection of the drums and the fingers. A combination of high-tension switch and transformer is made for underground lighting. The cast-iron case of the upper part contains a maximum release in oil, and can be also provided with plate-protected openings.

A British Study of Explosion Prevention

A paper on "Safety Devices in Connection with Electrical Machinery and Apparatus for Coal Mines" was read by D. Bowen and W. E. French before the British Institute of Mining Engineers in London, on June 6, 1912, an abstract of which was printed in *London Electrician*, Dec. 20, 1912.

The first thing that they discussed is what is known as "pressure heaping" in a fully inclosed casing with communicating divisions. The explosion in one chamber forces the gases into the other and compresses them to upward of 1½ to 2 atmospheres and the explosion of the compressed gases is so violent that a greatly increased mechanical stress on the various parts is brought about. Numerous actual cases were cited.

In the experiments on safety devices at the Mining Department of the University of Leeds, the authors of the paper started out to verify the work of Goetze in 1906, some of whose statements they doubted. To overcome the transmission of flame from the interior explosive atmosphere to the exterior, the following suggested systems were taken up: (1) flange protection, (2) oil protection, (3) wire-gauze or perforated-plate protection, (4) plate protection, (5) tube protection, (6) labyrinth protection.

Flange protection is involved when the products of combustion are forced to leave through flange joints under high pressure and velocity in single thin and easily-cooled layers. Owing to their high pressure of exit and consequent rapid expansion to atmospheric pressure, cooling of the gases takes place due to this expansion alone and considerable cooling is effected by the passage of gases between wide flanges spaced a very small distance apart. Goetz reported that a ratio of 132 sq.in. cross-sectional flow per cubic foot volume of the apparatus (4.65 sq.in. per liter) secured safety, and that with closed cases for switches, resistances or motors, the small and narrow clearances between shafts and bearings or at lids and doors, etc., were not dangerous if not exceeding $^1/_{25}$ in.

The authors of this paper conducted tests similar in all respects to those of the German experimenters, and they found that Goetze's ratio did not necessarily secure safety. Unless unusually wide flanges were used, failure occurred with flange clearances of much less than $^1/_{28}$ in.; with a flange width of 0.55 in. and a gap equal to 0.006 in., failure occurred. In one case where the end covers were bolted on tightly to bring the flanges into contact, one bolt was inadvertently left loose; on the explosion of the inside mixture a flash of flame 3 in. long shot out of the apparatus at the small gap thus afforded.

In arranging wire-gauze protection, they found that several conditions must obtain; (1) there must be sufficient time for the absorption of the heat by the wire gauze, that is, the velocity of the gases must not be too great through the screen, (2) the metal of the gauze must be well distributed to possess the capacity of absorbing heat in available time, (3) the wire must not lose its mechanical properties due to stresses of explosion or melting. Steel possesses better thermal characteristics, but is easily attacked in mines, and brass or copper becomes preferable. Goetze has claimed that if a gauze surface was provided with at least 43.6 sq.in. per cubic foot of explosive mixture (1.54 sq.in. per liter) contained in the apparatus, then the apparatus was safe, and that where

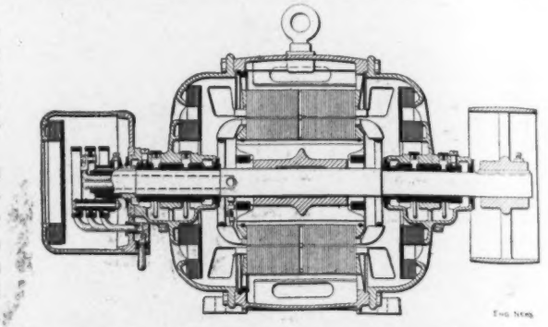


Fig. 3. Section of an Induction Mine Motor with Plate Protection

(Allgemeine Elektricitäts Gesellschaft, Berlin).

pressure heaping was set up, sufficient cooling and protective action could be secured by building into the apparatus several series of gauze partitions.

In the writers' experiments, apparatus fitted with 371 sq.in. per cubic foot volume of apparatus (13.1 sq.in. per liter) showed complete failure, and also with two, three and four layers of gauze in series. They encountered after-burning wherever it was possible to provide a constant flow of gaseous mixture into and out of the apparatus case.

In studying plate protection, the writers confirm the results of German tests that it was not safe to arrange the plates more than $^1/_{50}$ in. apart, and under this spacing absolute safety was obtained under every possible condition of tests. It was recommended that only such a number of plates with $^1/_{50}$ in. gap should be placed in parallel as to guarantee the necessary cross-sectional flow for easy ventilation. The effects of after-burning were noted only to a very small degree and the construction was found to lend itself to a better and stronger mechanical design. Plate protection by them is regarded as the most reliable. They believe that forced ventilation can readily be arranged for by adding fan vanes to the rotor or armature of an electric motor. The authors evidently did not follow out tests of motors equipped with

plate protection and fans, as did the U. S. Bureau of Mines, for they did not mention the serious after-burning of indrawn gas.

Goetze had held that the desired safety could not be obtained by forcing the gaseous products to travel along a long cooling path as through a tube because the number of tubes could not be confined within practical limits. The authors hold that all that is necessary is to furnish the apparatus with many narrow and long ducts packed into a comparatively small compass, though they suggest no specific design.

A somewhat similar solution which had been suggested was that of providing a labyrinth by arranging several metal sheets with the separating spaces connected in series by holes arranged alternately at the top and bottom of the plates; but the authors hold that ventilation of the appliance is impaired in this case and that the type is dangerous since pressure heaping and rupture is liable to occur, as the chamber is subdivided into a number of small interconnected spaces.

The writers agree with Goetze that the indiscriminate use of oil submersion for protection is not advisable. Certain precautions are recommended for oil switches: (1) The current densities at contact surfaces and the contact resistance should be low to prevent heating. Without this precaution, the oil decomposes or vaporizes, and if the oil level is close to the switch contact, flames may break through to the surface and fire any explosive mixture above; (2) the contact should be placed near the bottom of the oil tank; (3) the case should be of sound mechanical construction and supplied with flange protection for pressure release. The writers believe that the submersion of multicontact switches and drum controllers for use in starting and regulating machinery has proved a complete failure (in contrast with the A. E. G. apparatus noted), since a low-contact resistance between fingers and contact blocks is impossible.

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The City's Side of Grade-Crossing Elimination*

By Robert Hoffman†

The changes made when abolishing grade crossings often make possible certain betterments in the railway, such as a better grade or a wider right-of-way, and the building of more tracks. The city, however, seldom obtains either a better street alignment or a better street grade. There is, of course, an indirect benefit on account of the safety and the ease of traffic over the streets.

PROPERTY DAMAGE AND IMPROVEMENT—On the other hand, considerable damage often results to property. Abutting land improved in reference to the original grade of the street may be left either considerably above or below the changed grade. This frequently involves a partial or total reconstruction of buildings, and in some cases the change in grade has been so great as to unfit the building for occupancy. The law provides that property so damaged shall be compensated to the amount of such damage, but should the buildings lose their tenants and business go elsewhere, it means that temporarily, at least, the entire section surrounding an undertaking of this kind is to some extent damaged. Vacant property may be left so far above the new grade of the street that no one cares to undertake the expense incident to building upon it. This brings about an unsightly appearance, in that frequently the side slopes of the property are left rough and unfinished, allowing mud and dirt to wash down upon the sidewalks. This unfavorable condition may be temporary, as there is always a possibility that the land may be improved.

It is to be regretted that when the work of eliminative grade crossings is undertaken the improvement of abutting property cannot be made simultaneously. The law, however, gives the city no power to enter upon private land in order to build retaining walls, grade side slopes, or change buildings that will interfere with the private rights of the owner. The changes must be confined to the limits of the roadway unless land necessary for walls or slopes is appropriated. Such appropriations would often delay the work, and are, therefore, undesirable where they can be avoided. In Cleveland, where it becomes necessary to build retaining walls or grade side slopes upon abutting property, the policy is to make the doing of this work one of the conditions of the damage settlement. In the early cases, the damage settlement was made, and the money paid to the property owner, who was allowed to do as he wished as regarded his property. Several cases arose where the property owner, though claiming that he would be obliged to build a retaining wall, or to grade his property and to plant grass or trees, failed to do this after having received his damage settlement. To prevent this, payment of money for damage settlements should only take place after the property owner has properly protected abutting land, and done what is necessary to prevent an undesirable condition from arising.

BRIDGES—The city is interested in the sightly appearance of the structures that are built, so far as they may be seen from the streets. Should the roadway be carried over the railway, the railings of the bridge should be neat in appearance, and it is desirable that no part of the structure should extend above the roadway, with the exception of the railings. Deck structures are, therefore, desirable wherever they can be obtained. The through-truss or through girder often fails to present as pleasing an appearance as an unobstructed roadway such as can be obtained by the deck structure.

Where the roadway goes underneath the railway, it was at first thought desirable that the roadway should be clear from all obstructions, and several of the earlier bridges built in connection with grade-crossing elimination were provided with clear spans extending between abutments placed at the side lines of the streets. This made necessary the construction of deep girders, considerably out of proportion to the clearance provided between the bottom of the same and the roadway underneath. In later structures, curb supports have been generally adopted, and as a consequence, the girders carrying the bridge have been made shallower and present a neater appearance.

Though theoretically it might seem a good principle that the roadway should be left free of permanent supports, there is hardly a case in the city where numerous temporary encumbrances have not been constructed at the curb lines in the immediate vicinity of such grade-crossing bridges. Reference is made to the many telegraph and trolley poles, water hydrants, trees and like obstructions. As there is seldom need for vehicles to stop alongside the curb underneath the bridge, there is really less argument in favor of a wide unobstructed roadway in such a location, than there would be in other portions of public streets. It can, therefore, be stated that for widths of over 40 ft. column supports at the curbs are not objectionable.

*Abstract of a paper in the Journal of the Cleveland Engineering Society, Cleveland, November, 1912.

†Chief Engineer, Department of Public Service, Cleveland, Ohio.

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Improvement of the Illinois & Michigan Canal, from the Chicago River to the Illinois River, is being advocated, although the canal is now practically abandoned. Mr. Norman Fraser, President of the Chicago Portland Cement Co., has asserted that this condition is due largely to the failure of manufacturers and shippers to realize the advantages offered by this waterway. Last year some experimenal trips were made by this company between La Salle and Chicago, using an old barge and steamboat. The time occupied was about four days. There was no saving over the railway rate, owing to the small cargoes (186 and 200 tons) and the antiquated craft employed. It is estimated that with the canal cleaned out to a uniform depth of 7 ft., and with locks increased to 170x35 ft., it would be possible to operate modern craft handling 2000 tons and making the trip in 2½ days, or somewhat better than the present railway freight service. A fleet for such a cargo would consist of a steel power boat ($18,000) and five steel barges, 140x17 ft. ($15,000 each), all of 6-ft. draft. It is thought that with a steady volume of traffic and good terminal facilities the saving in cost of transportation (estimated at 5 mills per ton-mile) would warrant the investment. As to the improvement work, it is stated that $1,000,000 would suffice to rehabilitate the canal, which is owned by the State of Illinois.

FIELD AND OFFICE

A Pipe-laying Derrick and Power Backfiller for Trench Work

The great amount of trenching required in the construction of sewers, drains, water mains, etc., has led to the development of numerous machines and devices to facilitate and expedite work of this kind. Several forms of trench-excavating machines are in use,* and there are other devices used in connection with this work. We illustrate herewith two such devices, invented by F. J. Monahan for use in his contracting work; he is also the inventor of a trench-excavating machine (ENGINEERING NEWS, Mar. 16, 1911) and steel forms for concrete catch-basins and manholes. These various devices are now being manufactured and put on the market by Wm. Heggie, of Joliet, Ill.

PIPE-LAYING DERRICK—In laying sewer pipe and drain tile in trenches there is often much loss of time and breakage of material due to inefficient handling of the pipe, and this is especially the case where large and heavy pipes are being handled. Many contractors rig up home-made derricks, but Fig. 1 shows a simple portable device manufactured for this purpose, as noted above. It is shown at work immediately behind a trench-excavating machine. The cranked axle *A* is carried by a pair of wheels riding on planks laid at each side of the trench; upon this axle are mounted standards with bearings for the shaft of the drum *B*. A brace-frame *C* supports the derrick in position, and its legs are swung up clear of the ground when the derrick is to be moved. The wheels are 38 in. diameter and 6 ft. apart, and the axle and brace-frame are of 2-in. pipe. The rope drum is 25 in. long, and operated by a crank handle *D*, with a single pair of spur gears. To the end of the rope is attached a U-shaped pipe-hook *E*, and the descent of the load is controlled by a rope brake on the drum. The derrick weighs 150 lb., and has a capacity of 1 ton.

*"Engineering News," Feb. 23, Mar. 16 and Apr. 6, 1911.

FIG. 1. A LIGHT PIPE-LAYING DERRICK

FIG. 2. A POWER-OPERATED SCRAPER FOR BACKFILLING TRENCHES

POWER-OPERATED BACKFILLER—In backfilling trenches, a somewhat common practice is to hitch a horse to a rope attached to a scraper on the opposite side of the work, the scraper being hauled forward by the horse and moved back by hand for the next haul. A more rapid and effective method is to use a light hoisting engine to operate a scraper, as shown in Fig. 2. Here a 10-hp. engine and boiler are mounted on a frame carried by small flanged wheels on a short piece of portable track of 5½-ft. gage, but the machine may be mounted on traction wheels and may be made self-propelling. The scraper is a large flat board (with no pan), fitted with arms for attaching the chain bail, and having a wheel at the back for convenience in running it back from the trench. It is operated by two men at the handles, by which the scraper is tilted back to take its load and tilted forward to throw the material into the trench. A third man operates the engine. For filling a trench in soft and caving ground the rope was led through a snatch-block and attached to a drag scraper, operating this longitudinally so as to spread the caving material over the pipe already laid, and to trim out the bottom for the new pipe. It is stated that in ordinary backfill work one machine will do as much work as five or six scraper teams, with two or three men to each team, and that in a working shift of ten hours it has filled 200 ft. of 33 in. trench 12 ft. deep.

A Tamping Machine for Backfilling Trenches

The backfilling of trenches is a troublesome problem on work in paved streets, owing to the difficulty of getting the fill so thoroughly tamped that there will be no settlement of the paving when relaid over the trench. This problem is encountered by contractors and municipal authorities as well as by engineers, but with the class of labor commonly employed it is not easy to get the work done well or in the way specified.

To meet this difficulty, and at the same time to reduce the labor cost, a tamping machine has been introduced and has been used in a number of cases with satisfactory results. This machine is shown in the accompanying cuts, Fig. 1 being a side elevation and Fig. 2 an end elevation of the machine at work on a pipe trench. The machine consists of a truck carried by two 36-in. wheels (and supported at the rear by legs), upon which is a long frame or sweep, which is pivoted over the truck axle and is composed of a pair of 3-in. steel channels stiffened by truss rods. It is swung to and fro horizontally to cover the desired width. This frame carries a small gasoline engine at one end, while at the forward end is a train of gearing which gives a vertical reciprocating motion to a long bar or timber fitted with a tamping head. The wheels and the shoes on the rear legs have a vertical adjustment of about 8 in., so that the machine can be set level when working close to the curb, with one wheel and shoe on the sidewalk.

The vertical beam or lifter bar is of hardwood, faced on two sides with small steel channels which slide in the channel guides supported by diagonal braces from the frame. The lifting mechanism consists of two rolls placed on opposite sides of the lifter bar, geared together and driven from the engine by a belt. The front roll is pressed against the tamper by coiled springs, and a portion of the circumference of each roll is cut away so as to release the tamper automatically. Thus the tamper is gripped, raised and dropped once with each revolution of the rolls, the length of stroke being 2 ft. The number of strokes is from 50 to 60 per minute. When not in use, the tamper is held in the raised position by a pair of dogs or grips attached to the guides and held against the bar by springs. When it is desired to stop the tamper (while the engine is running), these dogs are released or thrown into action, and they then prevent the tamper from dropping at each revolution of the rolls; the rolls will then raise it to the full length of its travel, but as the size of the tamper bar is reduced near the bottom, the rolls lose their contact with the bar, which then remains held in the raised position by the dogs.

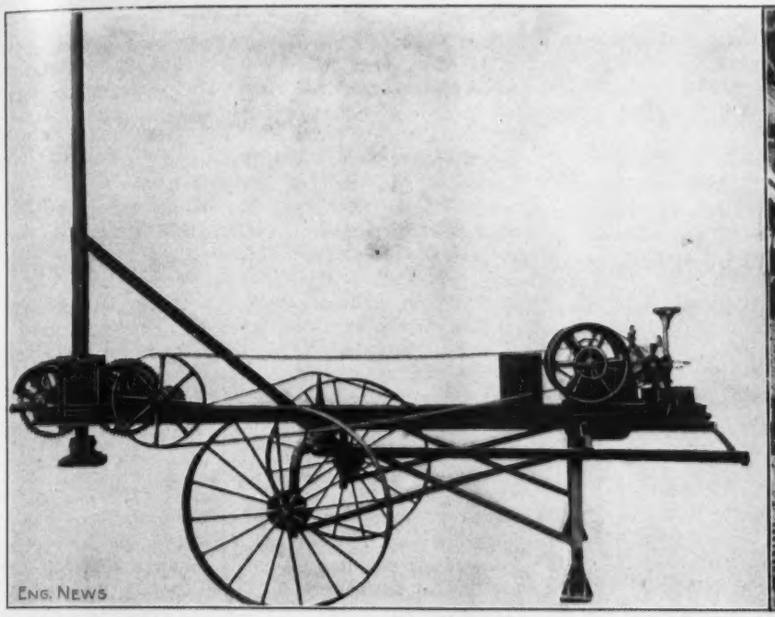

FIG. 1. POWER TAMPING MACHINE FOR TRENCH AND SURFACE WORK (Lourie Mfg. Co., Springfield, Ill., Builder).

FIG. 2. TAMPING MACHINE AT WORK ON A PIPE TRENCH

When equipped with a 10-ft. bar, the machine can tamp to a depth of 6 ft. below the surface, which is considered sufficient for trenches as deep as 9 ft., owing to the force of the blow. The tamping head is 8x9 in., weighing 80 to 90 lb. The bar may be made 16 ft. long, enabling the machine to work to a depth of 12 ft. For the greater lengths the weight of the tamping head is reduced, so the total weight will not exceed 100 lb., the head being made sometimes of steel plates and angles instead of a casting. On small trenches and on surface work where the footing is good the machine may be handled by one man, but ordinarily two men are used, one on each side. It is stated that for surface work, two men with the machine can tamp 1200 to 1500 sq.ft. per hour, making one pass. In a 30-in. trench work, they can tamp ten layers in 40 to 50 lin.ft., making one pass over each layer (1000 to 1250 sq.ft.). The weight of the machine is about 950 lb.

Five of these tamping machines have been used by the

McCrary Excavating Co., of Atlanta, Ga., which states that their work is far superior to hand tamping; it is found that all the earth taken out is put back, and even after very heavy rains there has been no settlement. In one case where a trench was being filled by hand labor there were 23 shovelers and 23 tamping men; a machine was put on this work, with two men to operate it and one man to level the fill in the trench. Thus, 20 men were eliminated and the work was done more effectively. In fact, on this one stretch the saving paid for the machine in a few days. At Wilmington, Del., a machine has been used in filling pipe trenches, and Alexander J. Taylor, City Engineer, has stated that it appeared to do the work for about six shovelers; in some cases where the pipe did not exceed 10 in. diameter all the excavated earth was put back, so that none had to be hauled away. The Central Indiana Gas Co. has used the machine, and the Minneapolis Gas Light Co. reports that the machine with two men does the work formerly requiring ten men. Five of these tamping machines have been used by G. M. Gest, of New York and Chicago, contractor for underground electric conduit work, and he has reported a saving of $8 per day per machine, as compared with hand work.

The machine is the invention of R. H. Staley, and is being manufactured and introduced by the Lourie Mfg. Co., of Springfield, Ill.

Erection Costs for a Double-track Railway Bridge

By M. A. O. Stilson*

The bridge whose erection costs are given in this article comprises three double-track through spans, each 154 ft. 6 in. long c. to c. The trusses are of lattice type. The piers are square to the track and trusses.

There were in place two old spans (single-track), which were taken out as the work progressed. For cutting apart they were blocked up on the falsework put in for the new spans. The grade of the new track was that of the old, the pier height above high-water allowing for the extra depth of the new floor-beams. The use of a derrick car enabled this work to go forward while the first new span was erected.

An overhead traveler (see Fig. 3) was used for the erection. It was assembled and raised from the old truss. The raising of a traveler becomes a simple and rapid task when old spans are in place to erect from, as the assembling can be in a position not far from the vertical, letting the upper frame of the traveler [illegible] on the top chord of the old spans and finally pulling [illegible] small distance to a perpendicular with tackle just [illegible]ior to joining the bents of the traveler. The traveler [illegible]ld also be raised from the flat floor of the falsework, [illegible] means of a jack-frame erected at the foot of the tra[illegible]r legs. This takes nearly twice the time of the other [illegible]ethod, and costs (a gang of 12 men can have a travele[illegible] framed and ready for use in three days with the help of [illegible] hoisting engine) about $300.

The piers of the new three-span bridge were so located that the masonry could be all completed, with the exception of a few bridge-seat stones to carry track stringers, before the arrival of the bridge steel, thus allowing the new shoes to be placed at once. A temporary trestle at the upstream side of the main line cared for the train movement, allowing the erection to proceed undisturbed by the traffic. Therefore, the falsework had to be proportioned for the trusses alone.

The height of the piers above mean low water was about 27 ft. The river bottom was a well washed gravel, into which a pile could be driven to a penetration of 5 ft. only with difficulty.

The sequence of operations in the erection of the bridge was as follows: (1) Ship equipment and materials to bridge site; (2) unload; (3) place hoister and compressor and house them; (4) put in falsework; (5) erect traveler and wreck old spans; (6) place and block floor-system and bottom chord, cambered; (7) erect web-members; (8) place end posts; (9) place top chord; (10) place bottom and top laterals, with portals and other small members, or release traveler to second span; (11) rivet up; (12) strike falsework and traveler; (13) load material and equipment.

Cost of Shipment—The cost of shipment of equipment and material to the bridge site is an item varying in each case, and also depending on the terms of the contract with the company owning the bridge. If a railway company, the contract may include transportation and work-train service during erection, though these items are properly a part of the cost, no matter by whom paid. It is not unusual, however, for a charge of $25 per day to be incurred for a locomotive, flat-cars and crew, especially where the bridge members have had to be unloaded at a distance. The economy effected through the use of a derrick car capable of propelling itself and loaded flat-cars thus becomes apparent.

Cost of Unloading—The unloading of the material and bridge members at the site or some adjacent point, while variable, will generally be covered by the expense of a derrick and hoister, its erection and a possible shift, if the ground available makes this necessary. In the present case the material for the three spans was unloaded in about three weeks, including delays, by a gang of eight men, one engineer and one foreman, about $200 per week for labor cost.

*23 Roseland Ave., Waterbury, Conn.

Figs. 1 and 2. Two Views of the Three-span Double-track Railway Bridge

Hoister—Placing the hoister, compressor and their boilers is comparatively a small item unless considerable falsework be necessary for support. In this case three bents of six piles each, capped and braced, with plank floor, were placed, and the power set, by 12 men and one foreman in four days, costing $200.

Falsework—The erection of the falsework, consisting of nine bents, capped and braced, floored with timbers parallel with the bridge and some plank, can go forward during the same period. The equipment of scow, pile hammer and hoister engine was able to drive 15 bents of 10 piles each (150 piles) in four days. The piles were delivered into the water above; they were of 25 to 27 ft. lengths, and were driven to a penetration of 5 ft. This gang consisted of one foreman, one engineer and four men, a labor cost of about $23 per day, according to rate of wages paid. The cost was, therefore, $92, or practically 62c. per pile in place. The piles cost 10c. per lin.ft. delivered above the work, or $2.50 to $2.70

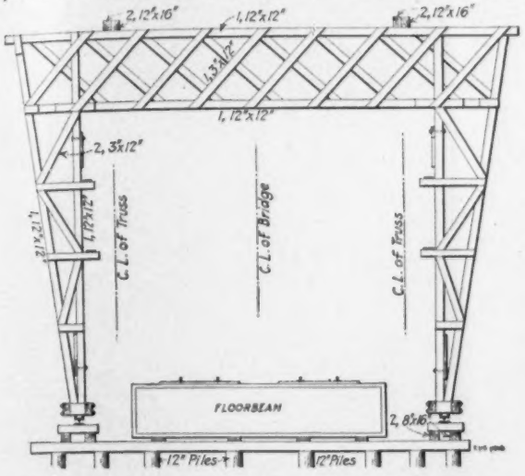

Fig. 3. Sketch of Bent of Wooden Traveler

apiece, making $482 the total cost of piles in place. (This figuring assumes that the equipment can leave the work in good condition, so as to be available at full value for other work.) Cutting off the piles, capping, boring and bracing, was completed in eight days by a gang consisting of one foreman and eight carpenters, at a cost for labor of $23.50 per day, or $188 total. This includes placing the timbers to carry the trusses, drifting them in place, and laying floor-plank and traveler track.

The labor cost of one span of falsework in place is thus $280. The cost of piling is $390, and of timber as follows:

30 caps 12x12 in. x 25 ft.	9,000 ft. B.M.	
12 saddles 12x12 in. x 8 ft.	1,152	
60 stringers 12x12 in. x 25 ft.	15,000	
120 braces 3x12 in. x 30 ft.	10,800	
80 blocks 8x8 in. x 8 ft.	3,411	
440 plank 2x12 in. x 12 ft.	5,760	
Cost		
40 M at $30	$1200	
6 M at 25	150	
		$1350
Total Cost of Falsework		
lumber	$1350	
piles	390	
labor	280	
	$2020	

This gives $2020 cost of falsework of one span in place ready for setting steel. In the three-span bridge in question, the riveting of Span No. 1 was completed early enough to release the falsework for use under Span No. 3, except for piling.

Traveler—The erection of the traveler has been stated to cost about $150. It followed the placing of the falsework, using the old spans to erect from. The cost of the traveler itself was as follows:

1 foreman, $4	$ 4	
6 carpenters, $3	18	
4 days at	$22	$88
4 legs 12x12 in. x 48 ft.	2304 ft. B.M.	
4 batters 12x12 in. x 40 ft.	1920	
2 bott. chords 12x12 in. x 36 ft.	864	
4 top chords 12x12 in. x 30 ft.	1440	
4 top timbers 12x16 in. x 30 ft.	1920	
16 braces 3x12 in. x 20 ft.	960	
24 braces 3x12 in. x 12 ft.	864	
4 diagonals 3x12 in. x 36 ft.	432	
4 sills 8x16 in. x 30 ft.	1280	
12 doz. ¾-in. bolts, etc., at 60 lb.	.05,	$36
4 flanged wheels, at 100 lb.	.03,	12
4 sets axles, bearings, etc., at 40 lb.	.03,	5
Cost of traveler		
lumber, 10 M at $35	$350	
" 3 M. at 25	75	
hardware	54	
labor	88	
		$567

Removing Old Spans—The wrecking of the two old spans occupied one foreman with 12 men two weeks, the pieces of the members being taken away by the derrick car.

Erecting New Trusses—The floor-system of one span, including bottom chords, was put in place, blocked up, and bolted, by a gang consisting of two foremen, 18 men and one engineer in five days, assisted by a derrick car with one engineer, one foreman and eight men, who brought the bridge members from the storage yard in proper order.

The truss members and hanger posts were placed in two days, and the shoes, end posts, and top chords in two days, the pins being driven and the connections fitted up. The portals and lateral bracing, top and bottom, were placed in two days, fitted up ready for riveting.

The riveting was by pneumatic hammers acting under a pressure of 90 to 100 lb. from a Franklin air compressor. A gang consisted of four men, eight gangs being operated during the major portion of the work, with one foreman and one supply man. The riveting of the three spans was completed in 39 days, or an average of 13 days to a span. A total of 60,000 rivets were driven in the three spans, with an average of less than 3% cut out and redriven.

Striking and Loading—The striking of the falsework followed the riveting of its span. The material was then loaded for shipment. The equipment, including traveler, pile-driver, and scows with hoister, was then loaded, freeing the hoisting engine, air compressor with tank, pipe and boiler.

Appended hereto are tabulated the labor and lumber items, showing at a glance the approximate cost per span and per ton. In a bridge of three or more spans the progress of one span's erection so laps that of the succeeding one, under good management, that the inference that the erection cost of a single-span bridge is 33% would lead to some error, as several of the general charges would be unchanged for one-third the number of spans.

The assumption has been made that an equipment such as has been described was in the hands of the erection company. But since it would be proper to add a charge not only for depreciation, but for interest on the invested funds, a value on which to base such is also given, the

items of which are mostly estimated, although some are actual costs. A sketch of the traveler is also given. The traveler consisted of two bents suitably braced, supporting four timbers 12x16 in. x 30 ft., two over each truss, to carry the blocks of the main falls and smaller tackles.

Exclusive of the time taken to unload the bridge members at the site the erection of the bridge was completed in nine weeks from the arrival of the forces. This includes wrecking the two old spans.

ERECTION COST OF THREE-SPAN DOUBLE-TRACK RAILWAY BRIDGE.

First cost of equipment		
Air compressor	$800	
Tank and pipe	200	
3-drum hoister	1900	
8 coils rope	400	
Blocks, etc	550	
Piledriver, scows and conductor	500	
Hammer, falls, etc	150	
2-drum hoister	1000	
Derrick car (est.)	4000	
Traveler	600	
Total	$10,100	
¼ year interest, 6%	$202	
¼ year depreciation, 10%	343	
		$545
⅓ for one span		$182
Labor cost of erecting span No. 3.		
Superintendent 30 days at $8	$240	
Foreman 38 days at $4	152	
Men 832 days at $3	2904	
Engineer 43 days at $3	150	
	$3446	
Unit cost (weight of span 587 tons)	$5.50 per ton	
Total erection cost of span No. 3		
Labor for erecting	$3446	
⅛ cost erecting hoist	70	
⅛ cost erecting traveler	50	
⅛ cost unloading material, etc	200	
¼ interest and depreciation	182	
Total erection cost for 587 tons	$3948	
	$6.72 per ton	

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Novel Construction of Concrete Foundations*

By W. G. Kirchoffer†

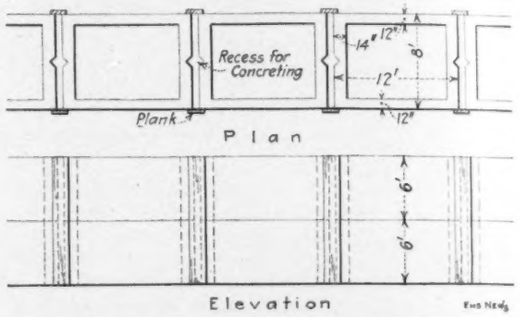
This refers to a method of constructing reservoir walls and foundations for small dams, bridges, etc., where the materials to be excavated are water-bearing sands and gravel, quicksand or other materials which will not be self-supporting and would require complicated or expensive sheeting and bracing.

For many years, large round wells and small storage reservoirs have been constructed of brick or stone masonry built upon a wooden or steel cutting shoe, the wall being carried up as its weight causes the shoe to sink with the excavation of the soft material. With reinforced concrete the trouble from cracking of the walls due to unequal settlement is largely eliminated. Simple and inexpensive forms may be used and the steel or wooden shoe omitted. I have made the forms of 1-in. matched flooring nailed vertically to horizontal ribs built of two thicknesses of 2-in. plank. The inside form braces itself and the outside form may be held by two rods or cables with turnbuckles.

When the surface material is solid for five or six feet the excavation usually precedes the starting of the wall. Then the forms and reinforcing materials are placed in the excavation and a ring of concrete is poured. This is usually allowed to set for a day before removing the forms or starting the excavation again. As the excavation is carried down, the walls will sink and the forms may be placed again at the top of the completed portion and again filled. This process can be carried on until the desired depth is reached. Where large quantities of water or quicksand are encountered, it will be necessary to use a power pump continually. Reservoirs built after this method were constructed successfully and economically at Munising, Mich., and at Medford, Marshfield and Shawano, Wis. The materials excavated varied from water-bearing sand to boulder clay. The diameters were 35 and 50 ft. and the depths ranged from 15 to 25 ft.

The success of this method led to its use for the foundations of a concrete dam about 200 ft. long and 8 ft. high, upon the Kickapoo River at Viola, Wis., for the Viola Light & Power Co. On account of the size of the job and the remoteness of the place, it was necessary to do the work by force account and as cheaply as possible. For these reasons and because of the small amount of equipment available, the writer adopted the same method of construction for the foundation as he had used on the reservoirs, except that the forms were made to inclose a series of hollow rectangular blocks 12 ft long, 8 ft. wide, 6 ft. high and 1 ft. thick, as shown in the accompanying cut. These forms were of 2-in. plank, and built in a substantial manner so that they could be used several times. The concrete was reinforced with ½-in. round rods, spaced 1 ft. vertically and 3 ft. horizontally. The water in the river was from 1 to 3 ft. deep. The work was begun on the flats along the river and as excavation progressed the dirt was used for a cofferdam about the forms.

These rectangular sections were constructed end to end as they were sunk, and as soon as the top of one came close



Foundation for a Concrete Dam; Box Sections Sunk by Open Excavation

to the top of the water, another section was poured on top of it until a total depth of 12 ft. below the river level was reached. The material to be excavated was sand, gravel and clay, with some old logs and slabs. The openings between the blocks or sections were closed by pouring concrete in the V-shaped openings left at the ends. The space within the wall was filled with gravel, stone and clay. The whole foundation, including an apron in front of dam, was then covered with a slab of concrete 18 to 24 in. thick upon which the dam is to be constructed.

This method appears to be of much practical value where a full contractor's equipment is not available and work must be done at a minimum of cost and with inexperienced labor. It has the advantage of being cheap, it saves time, it eliminates many dangers of open excavation held by curbing and bracing, it is effective and the work is easily put in by men of little experience.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago, Jan. 22 to 24.

†Consulting Engineer, Madison, Wis.

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Three Radical Innovations in a New Steelwork Specification

A specification issued recently by the American Bridge Co., intended to apply to the design and construction of steelwork for buildings, towers, etc. (but not bridges), contains some clauses likely to arouse much attention among structural engineers. The company will use this specification for all of its own structural designing, and aims to secure its use by other designers. Copies may be secured by those interested, on application to the American Bridge Company of New York, 30 Church St., New York City, or any of its district offices. We quote here the three most radically new items of the specification.

1. A New Column Formula—The column formulas

in use today, giving the permissible unit-stress p in terms of the length-ratio $l \div r$, are of three kinds:

a. Formulas of the Gordon type; e.g.,

$$p = \frac{15{,}000}{1 + \frac{l^2}{13{,}500\, r^2}}$$

b. Straight-line formulas; e.g., $p = 16{,}000 - 70\,\frac{l}{r}$.

c. Broken-line formulas composed of two straight lines; e.g., the formula $p = 16{,}000 - 70\,\frac{l}{r}$ limited by the formula $p = 14{,}000$ as upper limit.

The new structural specification of the American Bridge Co. prescribes a *three-segment* formula, as follows:

For $\frac{l}{r}$ up to 60,*

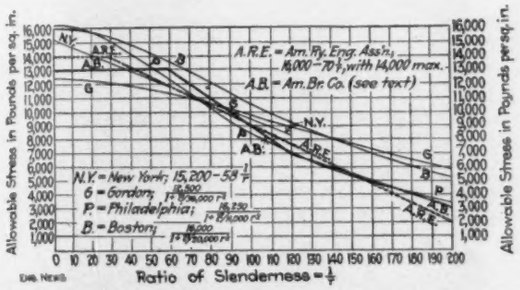
$$p = 13{,}000 \text{ lb. per sq.in.}$$

For $\frac{l}{r}$ from 60 to 120,

$$p = 19{,}000 - 100\,\frac{l}{r}$$

For $\frac{l}{r}$ from 120 to 200,

$$p = 13{,}000 - 50\,\frac{l}{r}$$


Allowable Stress in Pounds per sq. in.
A.R.E. = Am. Ry. Eng. Ass'n; 16,000 − 70 l/r, with 14,000 max.
A.B. = Am. Br. Co. (see text)
N.Y. = New York; 15,200 − 58 l/r
G = Gordon;
P = Philadelphia;
B = Boston;
Ratio of Slenderness = l/r

SOME WELL KNOWN COLUMN FORMULAS AND THE NEW THREE-SEGMENT FORMULA

The third segment has half the slope of the middle segment. If the main formula (that of the middle segment) were continued beyond 120 it would give a unit-stress of zero for $\frac{l}{r} = 190$, whereas the upper-range formula as prescribed gives $p = 3500$.

This set of three formulas when plotted on the base $\frac{l}{r}$ follows the general course of formulas of the Gordon type, but in use it differs from such formulas quite materially in the region $\frac{l}{r} = 40$ to 80.

The application of the formula is affected by the following clause found in another part of the specification:

The effective or unsupported length of main compression members shall not exceed 120 times, and for secondary members 200 times, the least radius of gyration.

*This does not refer to short blocks, but only to compression members long enough to be classed as columns. The compression allowed by the specification for pieces other than columns is 16,000, which figure is also fixed as the bending unit-stress. Pin and rivet bearing is 24,000.

Thus the formula $p = 13{,}000 - 50\,\frac{l}{r}$ is to be used only for secondary members.

2. PROPORTIONING PLATE-GIRDERS BY SECTION MODULUS—According to common practice, the flange section of plate-girders is determined like that of trusses or lattice-girders; i.e., the external bending moment is divided by the distance between centers of gravity of the flanges or chords (which operation gives the total stress in the flange), and then each flange is proportioned for its stress by making the proper application of tensile or compressive unit-stresses to net or gross cross-sections, respectively. This practice is subject to slight variations, some engineers counting the web-plate as resisting part of the external bending moment, while others disregard the web in considering bending. The new American Bridge Co. specification substitutes an entirely different procedure, described in the following simple clause:*

Rolled I-beams and channels and built-up members used as beams and girders shall be proportioned by their moments of inertia.

We are informed that this refers to *gross* moment of inertia, i.e., computed from gross sections. It is intended to be used for finding the section modulus I/c; where the distances from neutral axis to the extreme fiber on tension and compression sides differ, the largest c is to be taken, and thus the least I/c obtained. This latter is then multiplied by the allowed bending unit-stress (generally 16,000), giving the moment value of the girder.

Plate-girders being usually symmetrical or nearly so, the results from the use of the method specified are expected to be about the same as those of the common method. The specification states that members shall preferably be of symmetrical section.

The plate-girder clause is affected by a provision that when the unsupported length of compression flange (l) exceeds 10 times its width (b), the unit-stress in this flange must not exceed $19{,}000 - 300\,\frac{l}{b}$; and l must never exceed 40 b.

3. A NEW SET OF I-BEAM CONNECTIONS—The end-connection angles of I-beams and channels which have long been listed and shown in mill handbooks are replaced in the present specification by a new set, with the important feature that, for the larger beams, only one line of rivets is used in each angle-leg. All beams over 10 in. deep have 4x4x$\frac{7}{16}$-in. or 4x4x$\frac{1}{2}$-in. end-connection angles, with three rivets for 12-in. beams, four rivets for 15 and 18 (and 20), five rivets for 20 and 21, six rivets for 24, and seven rivets for 27-in. beams. Beams 8, 9 and 10 in. deep have 6x4x$\frac{3}{8}$-in. angles, with two rows of two rivets each in the beam leg; beams 5, 6 and 7 in. deep have also 6x4x$\frac{3}{8}$-in. angles, but with two rows of only one rivet each in the beam leg.

Together with a set of drawings and capacity tables of these connections, a set of rivet stresses is given for beam connections, which contains one item different from the stress allowance given elsewhere in the specification. The bearing value for "inclosed" condition (i.e., on a web gripped between two connection angles) is given as 30,000 lb. per sq.in. This applies to shop rivets only. It is stated that this high value, as against the 24,000 bearing value for shop rivets not "inclosed," is permitted "be-

*Based on unpublished tests, we are informed.

cause of the increased efficiency due to friction and grip."

These connection angles are stated to have been designed for bearing and shear *without considering moment;* and the allowable reactions listed for them are stated to agree with tests made under ordinary conditions of use. Such tests have not been published, so far as we know.

OTHER FEATURES—The specification has other items worth attention, but not radical in the sense of the three above cited. Such are: Loads include impact, *if any;* but no rule for impact is given. Wind during construction is to be taken at 30 lb. per sq.ft., but wind on the finished structure at 20 lb. Latticing of struts is to be proportioned for a shear equal to 2% of the strut load.

An Improvement for the Micrometer-Microscope

BY WILMER SOUDER*

The precision now required in the manufacture and test of various commercial instruments and materials has made the microscope an absolute necessity in every research and testing laboratory; its use is so general and constant that any improvement in the accuracy of its results or reduction in the time required for making observations is worthy of consideration.

There are various types of micrometer-microscopes; however, those most generally used for extreme accuracy are equipped with movable cross-wires, or spider-lines, beneath the eyepiece, and these may be moved across the image by means of a graduated head or nut (usually graduated to 100 parts around its circumference) turning on a screw attached to the frame supporting the cross-wires.

NEW MICROMETER-MICROSCOPE SCALE

After calibrating the pitch of this screw, in terms of the magnifying power, distances may be determined by making settings of the spider-lines on opposite sides of the image. These settings are made by bringing the spider-lines up to the image on, say, the left side, and taking the reading on the graduated head, then rotating the graduated head until the line appears to touch on the right, taking a second reading. This is usually repeated on the right, finally returning to the left, to insure that the initial position of the object has not changed. In many cases four settings are made on each side. The difference between the averages of the right and left readings, plus the whole number of turns, multiplied by the proper factor (called "screw value") gives the desired distance.

While engaged in measuring the diameter of wires in 100- and 200-mesh cement-sieve cloth by this method, the writer conceived the idea of making a device which would be much more speedy than the above method and possibly just as accurate. The diameter of a wire in unmounted cloth may be determined roughly by the use of a micrometer-caliper; if the cloth has been mounted on a sieve frame it is necessary to use the microscope. Practically all wires in 100-mesh cloth have diameters between 0.004 and 0.005 in. The new scheme consists in using a gage to fit magnified images of objects ranging between these values.

The gage consists of two diverging lines replacing the single spider-line, and so set that they caliper the image of the wire just as the original line touched the image. The divergence is such that a wire calipered at the wider end has a diameter of 0.005 in., while one calipered at the narrower end has a diameter of 0.004 in. Now if the intervening positions can be read with sufficient accuracy, the diameter may be determined to any degree of accuracy. To facilitate in taking these readings, I ruled eleven auxiliary lines beside the two diverging lines. The entire scale is ruled on a piece of cover-glass 19x19 mm. Its general appearance is shown (magnified) by the accompanying figure. This is mounted upon the regular spider-line frame of the microscope. After calibrating the lines, it is then only necessary to read the point along the auxiliary scale at which the image is exactly calipered by the diverging lines. If we estimate to tenths of a division on the auxiliary scale, we estimate the diameter to 0.00001 in.

The proper divergence and distance between lines may be readily computed by simple trigonometric formulas for any magnifying power. The lines are best ruled with a diamond attached to the circular dividing engine. Lines for limits other than those given above may be readily ruled.

Such a device is now in use in the U. S. Bureau of Standards. Some of its demonstrated advantages are given below:

(1) The variation in results, due to different observers determining the same distances, are decreased, on an average, by more than 30%. This would seem to indicate that it is even more accurate than the old method. It must be remembered also that observers taking these readings were experienced in the use of the old system and that this was absolutely new to each.

(2) The proper allowance for the width of the lines is more easily made.

(3) One sets to both sides of the object at once, consequently variations due to unequal lighting are reduced.

(4) The time required for measurements is only 25% of the original time required.

*U. S. Bureau of Standards, Washington, D. C.

An Exponential Computer

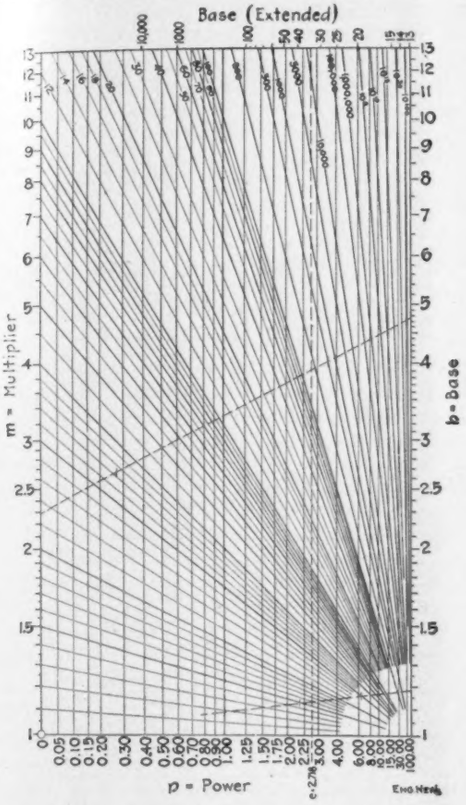
BY LOUIS ROSS*

Many problems that the engineer meets in practice require the solution of equations with mixed or fractional exponents. Among these problems may be mentioned: flow over weirs, friction of water flowing in pipes or in open channels, friction between solids, wind and frictional resistance of moving bodies, belting problems in power transmission, the laws of moving gases and generally of the properties of steam and gases, laws of magnetic properties of metals, hysteresis losses, electrical transmission of energy. There is also the natural law of variation according to the $e = 2.718$ power, which enters into a large field of the physicist and electrical engineer. A large part of all experimental laws are most accurately expressed by exponential equations. The actuary and accountant have the compound-interest problem

*Civil Engineer, 701 Sutter St., San Francisco, Calif.

to contend with. This list may be extended into wider ranges; in fact, nature has not made its laws follow our arbitrary integral exponent system; it is only the inconvenience of handling numbers with fractional exponents that has led the engineer to substitute for the exact laws other arbitrary approximate laws employing terms of simple integral powers.

The slide-rule handles primarily numbers having an exponent of 1, and by a double setting exponents of ½



EXPONENTIAL COMPUTING CHART, FOR SOLVING $n = mb^p$
(Designed and copyrighted by Louis Ross.)

and 2*. Outside the defined range no direct solution is possible. To fill the special needs of other exponents, special tables have been computed, and printed in the forms of handbooks giving powers especially used in a given field, as the $^3/_2$ power table, and the recent 1.7 power table issued to cover the magnetic field.

An Exponential Computer has recently been devised by the writer, which consists of a straight-line chart and a straight-edge, or better a fine hair-line drawn on a strip of transparent celluloid. This computer multiplies and divides, like an ordinary slide-rule, but in addition it gives at one setting any power, from 0 to infinity, or any root of any number; it will also, at one setting, multiply any number by any root or any power of any other number. Trigonometric or any other special functions can be handled by labeling one line on the chart with a scale of those functions.

*Log-log slide-rules handle fractional exponents. See Eng. News, July 8, 1909, p. 40.—Ed.

Expressed algebraically, the Exponential Computer will solve at one setting any unknown in the equation $n = mb^p$, and with two settings any unknown in the equation $x = m^y b^p$.

A reduced copy of this chart is given herewith. For the purpose of showing more clearly its construction and use, most of the intermediate coördinates have been omitted; the readings made in the worked examples are correspondingly crude.

Referring to the diagram, the left and right edges, labeled m = *multiplier* and b = *base*, respectively, carry logarithmic scales, and they are drawn any convenient distance (L) apart. The vertical lines are drawn at distances from the left represented by $L \frac{p}{p+1}$, where p is the power or exponent, indicated at the bottom. The base scale at the upper right corner is extended by folding it over the top marginal line.

The use of the diagram is based on the construction explained above, which is such that a line across the b and m scales cuts the vertical p line at the diagonal $n = mb^p$; i.e., any straight line across the diagram passes through the three points b, m and the intersection of p with the diagonal n.* Hence, pass a straight line across the diagram, and read whichever one of the four factors is unknown; two points being determined by the known factors, the third point solves the unknown.

EXAMPLES—Two positions of the straight-edge are represented by dotted lines in the illustration. The dotted line near the middle is cut by a dash in its left half, this intersection representing a reading of the formula $3.44 = 2.27 \times 4.76^{0.77}$. Any three of the elements of this formula serve for obtaining the line and the point where the fourth element may be read. Similarly, the dash in the right half of the dotted line marks the point which determines the relation $500 = 2.27 \times 4.76^{2.5}$.

The dotted line at the bottom of the sheet passes through $m = 1$, and solves equations of the type $n = b^p$. Thus, to find in how many years money will triple at 18% compound interest, the equation is $1.18^p = 3$. The dotted line passes through $b = 1.18$; where it cuts the diagonal $n = 3$, read $p = 6.6$ years. Likewise, to find how many years it will take money to increase 50% at the same rate, read on the same dotted line, at its intersection with $n = 1.5$, $p = 2.4$ years.

To make up a table of numbers raised to any particular power it is only necessary to draw a vertical through that power; pivot the straight-edge about $m = 1$ (lower-left corner), set its lower end on any number in the right-hand scale, and at the intersection of the straight-edge with the power vertical read the answer. Thus the power $e = 2.718$ has been indicated on the diagram by a vertical dash line. By its aid one reads on the lower dotted line $1.18^e = 1.6$.

The diagram has a pleasing mathematical finish in that it contains the full scope, from 0 to infinity, of each scale; and a still more pleasing practical aspect in that the most used range of powers and numbers is by far the most open and accurate. A scale of, say, tangents may be placed just above and parallel to the m scale, on the extension of the diagonals, for use as a multiplier; or below the base, if it is to be raised to any power.

The b and m scales need be extended to the value of 10 only; in the diagram they have been plotted to 13 to recover the space lost by the convergence of the lines in the lower right-hand corner.

The extended base (at the top, for $b = 13$ to 10,000) can be used only with $m = 1$. For any other value of m, first find b^p, then multiplying this by m, using the $p = 1$ line for this last multiplication.

*The proof can readily be derived by the interested reader.

The "Rainy Day" Theory of Office-work

(A plea for more office men in the field office on construction.)

By "Construction Engineer"

Why is it that in the matter of keeping up the records in the field offices on construction the "rainy day" fallacy still obtains to such an extent?

The theory underlying this is that the work of cleaning up the hundred and one little odds and ends which accumulate rapidly and unceasingly on any job will be done by the field party on the days when outside work is impossible. As it works out in practice, however, all members of the field party have their minds centered on the construction work, which is the *live* part of the job, and they find that a strong effort is needed to concentrate on a page of notes. The result is that unless the head of the party supplies a constant stimulus to work, the men under him are apt to carry their responsibilities very lightly and to regard the day's work as a formality beginning at eight and ending at five. The head of the party always has plenty to do, however, and if he kept the rest steadily and intelligently at work all day long he could do none of his own pressing work. The result is that the men chafe at the confinement, their attention lags, and they soon become restless and noisy, simply because they are essentially out of their element. The day passes and little real progress is accomplished.

In the winter season there is a little better opportunity for organized effort under this theory, but even in that season it does not always work out. There is always some field work to be done, and vacations, overtime and holidays break into the working period. Usually the result is that winter slips away with much left undone in the way of cleaning up defective records and making notes and drawings systematic and accessible.

Why not provide in the original organization an office man whose business it shall be to see that the notes and records are in proper form and are kept up to date? You say that this would add to the cost of construction. Does it really do so? Consider what is very likely to happen on the usual job which lacks such an office man. Everything runs along smoothly during construction, and after two or three seasons the work draws to a close, and the final estimate is taken up. The notes are gone over and duplications appear, with too much difference to be ignored. Conflicting elevations bob up in the most unexpected places without explanation. Owing to the rush of daily routine, the little side notes were not jotted down, and their absence is now fatal. At the time the notes were taken everything, of course, was clear, but since that time it has grown cold and forgotten. The force has changed and probably no one is left who was on the job at that time and who might explain away the confusion. Under the circumstances the contractor must be given the benefit of the doubt. Little items of this kind here and there soon run up to a surprising amount of money, enough to account for a good part of the office man's salary had he been there to save just such losses.

Or, assume that at last the estimate is out (probably overdue even then) and the contractor's extra bills are taken up. One item in these is found to cover, say, $1500 worth of work which you are morally certain should not be allowed. On looking into the notes you find a couple of pages that cover the point, you feel sure, but unfortunately they have neither date nor heading. In this condition you are unable to prove your side of the case, and very likely the item will have to be allowed—an amount which would pay the salary of an office man for a year.

Surely there are good reasons for establishing the policy right at the start of keeping everything up to date in the field offices and providing the organization necessary to accomplish it. This arrangement will exert a wholesome effect on all who come within its influence, for, while habits of procrastination may often grow to large proportions unnoticed, it is just as easy to form habits of the very opposite character. Having provided the proper organization, let it be understood that things are not to be allowed to drift along and that all branches of the work must be kept up to date. There is a snap and go in the resulting atmosphere which all will feel, and the result will be increased efficiency.

Current Observations With a Stadia Float

By B. L. G. Rees*

In conjunction with some protective bulkhead construction at the terminals of the Atlanta, Birmingham & Atlantic R.R., at Brunswick, Ga., it was necessary to make float observations at frequent intervals to determine the direction of the tidal currents across the location of the new entrance to the basin between the bulkheads to be constructed.

These terminals are located on the north shore of the East River about opposite where it joins the larger Turtle River, which flows into St. Simons Sound. The East River carries an abundance of fine light silt, particularly along the shallow shore water out of the main current. This silt is continuously moved about by the tides, and is readily deposited along the shores and where the current is retarded. After years of this silt deposit-

*Brunswick, Ga.; Resident Engineer for Barclay Parsons & Klapp.

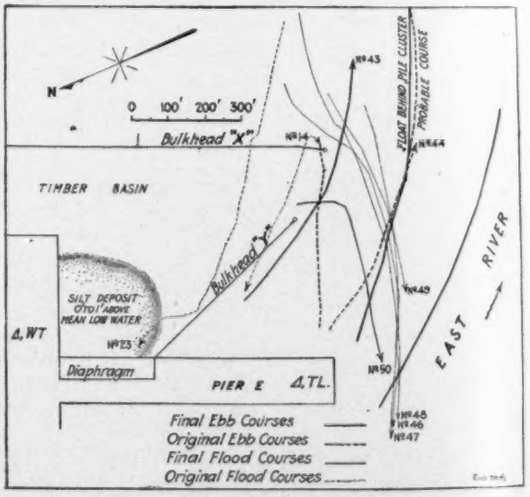


Fig. 1. Map of Area Covered by Current Observations, East River, Brunswick, Ga.

ing, the entrance and the basin at the terminal became so filled with silt that extensive dredging has recently been necessary to permit navigation. The new protective bulkhead construction completely closes this basin except for a width of 180 ft. between the bulkheads at the new entrance to the basin out near the current of the East River (see Fig. 1).

To be of greatest effect in clearing the basin of silt, the bulkheads were built with their outer ends on a line parallel to the average tidal current which carries the silt. Therefore it was necessary to make observations

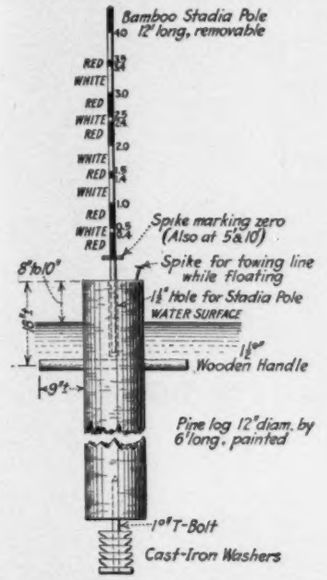


FIG. 2. STADIA FLOAT AND ROD

for determining the direction of the currents. As most descriptions of float observations are meager and lacking in practical details, special methods had to be devised for the work.

The controlling conditions were as folows: At the basin entrance the tide ordinarily ranges about 7.5 ft., producing a considerable current—about 2.5 nautical miles per hour in the main channel. The water surface is generally choppy and frequently is rough with unusual disturbances from the wash of steamers and tugs. The width of the rivers precluded the use of sighting-ranges; ranges were also out of consideration because the object of measurement was direction of currents rather than velocity. Only one instrumentman could be used, and therefore intersection methods were eliminated. The observations had to be taken when other work permitted, which meant that frequently the observations would have to be made in undesirable weather.

After some experiments a combination surface-and-submerged float was tried, but this was discarded because of complicated rigging, unsteadiness in surface disturbances and being difficult to handle with two men in a boat, on choppy water particularly. The float finally adopted and about to be described gave entire satisfaction with a long list of observations in all kinds of water disturbances.

The float is shown in detail in Fig. 2. It is made of a well seasoned white pine log from which the bark had been removed, about 6 ft. long and about 12 in. in diameter. It was thoroughly painted two coats of red lead. About 18 in. from the top a 1½-in. crossbar was driven through at right angles to the axis and made to project a foot on each side, to serve as a handle. Into the bottom end was driven a T-bolt holding cast-iron washers sufficient to submerge the float vertically until 8 in. to 10 in. remained above the water surface. Into the center of the top was bored a 1½-in. hole to form the socket for the stadia pole. For towing, a line was made fast under the handle, and while floating free this line was slipped over a spike driven into the top of the float log.

The stadia pole was the main feature of the complete float. It was made of a straight bamboo pole about 15 ft. long. Bamboo was selected for its strength combined with lightness and cylindrical form. The foot marks were painted alternately red and white enamel around the pole, while between 0.4 and 0.5 ft. points in each foot space there was painted a band of the other color to mark the half foot and serve as a gage in estimating the tenths. The zero-mark of the pole was made to be about 2 ft. above the water when the pole was in position in the socket of the float. The zero, 5-ft. and 10-ft. points were marked by 20-d. nails driven across the pole. Although this stadia rod reads only to tenths of a foot, the results are close enough for the practical purpose for which it was designed, when plotted on a scale of 100 ft. to an inch. Finer graduations for this work would only complicate the observations and would be useless on a float moving 1.5 ft. per sec. with the current and moving vertically with the surface disturbances.

The float proved to be very steady in rough water and was practically undisturbed by wind because of the light round pole which gave so little resistance compared to the submerged float. Serious disturbances were caused by counter under-currents around piers and piles, but it was seldom used in such areas.

The float was handled by one man from a motor boat. When being towed, the stadia pole was slipped from the socket in the float and laid on the deck. The line attached to the float under the crossbar was made fast to the forward cleat, allowing the float to come alongside well ahead of the propeller. Arrived at the point where a "run" of the float was to start, after the boat had stopped and the float had settled into a vertical position the pole was slipped back into place in the top of the float, the towing line dropped onto the spike in the top and the float swung into the current.

The observations were made from an elevated platform at the end of the long pier (*TL* in Fig. 1), which point was about on a line with the current direction across the approximate position of the entrance between the new bulkheads. A tide-gage was set where it could be read from the instrument at any time during the observations.

The observer set up at the station on the platform, oriented the instrument from the water tank (*WT* in Fig. 1) as zero, and attached a watch to the transit for noting the time of each stadia reading. The upper motion and the horizontal axis were clamped sufficiently to hold any set position. Using the vertical slow-motion screw the observer followed the stadia pole until simul-

FORM OF FIELD NOTES.
(Notes for observation No. 43, as shown on map Fig. 1.)

Lefthand Page						Righthand page
Date	Stadia	Hor. Angle	Time	Gage	Tide	Remarks
Oct. 26, '12	310	34°—40′	10:30A	4.9	Spring Ebb	Calm
43	310	42°—40′	:30½		H.W. 7:19 AM	Bulkheads Completed
Hadden	350	57°—20′	:32			
Observer	410	69°—50′	:33½			
	490	78°—0′	:34¼			
	540	80°—55′	:35			
	600	83°—0′	:36			
	710	84°—45′	:37			
	800	85°—35′	:38			
	910	85°—15′	10:39			Wind 112° 30′
44						

taneous readings were made with both stadia wires. The stadia, time and horizontal angle were then noted. The tide-gage was read as often as necessary. This completed the field observation. After a little practice such observations were made at a rate a little better than a "shot" or reading to the minute. Readings on the float were continued until the distance was about 1000 ft., unless stopped for other reason.

Each run of the float or continuous set of observations was given a consecutive number, which served to identify it both in the field and on the plot. The date, weather, angle of the wind and observer's name then completed the field notes. The form of complete notes for one run of the float is shown in the table below, which is a copy of the notes taken for run No. 43 as shown plotted on Fig. 1. The angle of the wind was taken by swinging the telescope of the transit into the wind and noting the horizontal angle.

In the office the times of high and low water were computed from the tide tables, and from this time the hours and minutes of the quarters of the tide were figured, also adding the nature of the tide (spring or neap). The condition of the tide makes distinct differences in the current velocities and direction, for the same time after slack water.

The observations were then plotted by the usual methods for stadia surveys; then the number of the "run" was added (as shown in the small circles on Fig. 1), and the direction of the current was indicated by an arrow. The current velocities, while not precise, were reasonably accurate as determined by scaling a distance between known time points after the float was well started. The only method for accurate velocities would be by the use of a current meter.

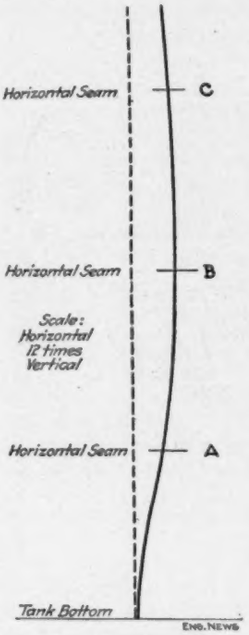
The map, Fig. 1, shows the area where over sixty "runs" as described have been observed during the past five months. The dotted lines are the plots of the typical currents before the diaphragm and bulkheads were constructed during the past summer. These currents show how and where the silt has been carried and deposited. They demonstrate clearly the need of protective bulkhead construction on lines to deflect these currents.

Construction work was completed about Nov. 1. The full lines, plots of observations made since the construction work was completed, show how successfully these currents have been deflected to clear the new entrance to the basin. About slack tide there are eddies formed across this entrance, but any deposit will be slight and probably be cleared by heavy-draft steamers. Around the outside of the entrance the line of demarkation between the clear water of the basin and the muddy water of the river is very definite.

Barclay Parsons & Klapp, 60 Wall St., New York, are engineers for this work, with the writer as resident engineer and G. Hadden, as assistant engineer.

Tank Design. Behavior of a Large Gas-holder Tank

In connection with a further reference to the matter on tank design discussed on p. 170 of our Jan. 23 issue and p. 1153 of our Dec. 19 issue, an interesting statement on the distortion of a large tank is given in the following letter:



Sir—The further discussion of the proper design of steel tanks seems to require for its conclusion a comprehensive analysis of the elastic behavior of such a vessel under hydrostatic pressure.

Mr. Maguire's obvious error is that he conceives of the tank as being circumferentially elastic, but vertically inelastic. Its reasoning would require an assumption which conflicts with the established theories of the elasticity of metals and also with the known behavior of tanks under fluid pressure.

In order that our thoughts may be better directed to the problem, let there be assumed a steel tank 200 ft. in diameter and 45 ft. deep, such as would be used for a large gasholder. With the usual proportions, such a tank would have nine courses of plating in the height of the shell. These several courses would vary in height from about 4 ft. 6 in. at the bottom to about 6 ft. 6 in. at the top. The bottom course of plates is attached to the bottom of the tank by a heavy curb angle, which extends around the entire circumference. The top edge of the uppermost course is stiffened by a heavy curb, or in the case of a gas-holder by a circular girder. The thickness of the top course of plating is governed by practical considerations and is somewhat more than the stress conditions would require.

When the tank is acted upon by the hydrostatic pressure, there results a circumferential stretching of the metal which would be the same at all points from the top to the bottom, if it were possible to so proportion the tank plates that the unit-stress in the plating would be exactly the same at all points in a vertical plane. However, this is not the case. The bottom course of plating is restrained by its connection to the tank bottom and by the adhesion to the foundation, while the excess of metal, assisted by the top curb, or circular girder, reduces the expansion at the top to a very small increment.

Referring to the accompanying sketch, the heavy dotted line indicates the position of the tank wall before the application of pressure, and the heavy full line the position after distortion resulting from the pressure. The curve was deduced from observations made upon a very large steel tank, which contained some 15,000,000 gallons of water. It may be seen by inspection that the flexibility of the lowest course of plating in a vertical plane results in a diminution of the restraint of the tank bottom as the second course is approached, and that the maximum expansion is at or near the horizontal seam B. A computation of the unit-stresses based upon the observed distortion of the plates indicated that the unit-stress at A was six times that at X, while the unit-stress at the upper edge B of the plate A-B was 55% greater than it was at the lower edge A.

I would suggest that Mr. Maguire develop his theory in connection with the above observed behavior of a large tank.

Yours very truly,
HERBERT W. ALRICH,
Engineering Department, Consolidated Gas Co.
New York City, Feb. 4, 1913.

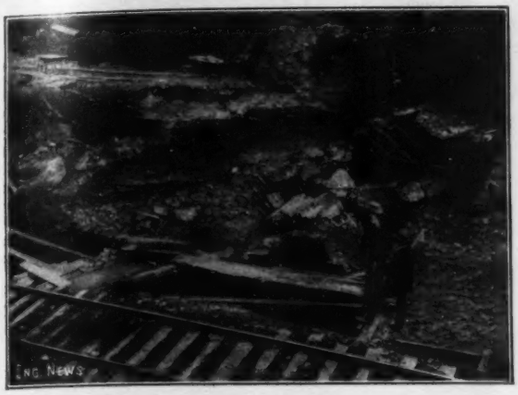
✠

Unit Costs of Removal of City Refuse by contract in Washington, D. C., during 1912 were: Garbage, per ton, $1.41; ashes, per cu.yd., $0.36; miscellaneous refuse, per cu.yd., $0.14; night soil, per bbl., $0.78; dead animals, each, $0.162.

NOTES

A Steam Shovel's Hard Job is well illustrated in the accompanying view sent us by Albert J. Himes, Engineer, Grade Elimination, New York, Chicago & St. Louis R.R. at Cleveland, Ohio. Mr. Himes writes:

The photograph shows an 8-ft. circular sewer encountered by a steam-shovel in excavating for the depression of the N. Y., C. & St. L. R.R. tracks at East 105th St., Cleveland. Through some misinformation the sewer was supposed to be about six feet lower, and the shovel coming upon it unexpectedly in the middle of the night, was obliged to break its way through the sewer or suspend work until the sewer



AN 8-FT. CONCRETE SEWER CUT THROUGH BY A STEAM SHOVEL

could be removed in some other way. The volume of flow through the sewer was exceedingly small and there was no objection to breaking through. This the steam shovel did successfully although the sewer was constructed of a first-class quality of concrete reinforced by 1½x⅜-in. flat bars 15 in. c. to c. placed transversely and five ½-in. round bars in the top placed parallel with its length. The shovel was a 70-ton, Bucyrus pattern.

Moving a Drag-line Excavator—After a drag-line excavator has been standing in one position for some time without being moved there is a tendency for the rollers to settle into the planks. This will make the moving of the excavator quite difficult and this condition is augmented by the collection of dirt and small pebbles beneath the rollers. It is also found in many instances that the planks will settle down at the point of contact with the rollers and the outer ends will raise, which practically necessitates starting the machine up hill when moving it. When an excavator is found in this condition it will be a very difficult job to pull it ahead with a steady pull of the cable, in fact the cables are likely to be snapped because of the tremendous strain put upon them.

The proper procedure, after the chock and braces have been removed and the bucket has secured a good hold in the material ahead, is to throw in the clutch and then to slowly open the throttle until a good strain is obtained upon the cables, when the clutch should be quickly thrown out. This will permit the machine to return to its former bearing and go a bit beyond. By again applying the strain on the cable at the proper moment the machine can be rocked back and forth on the rollers until the latter are clear of the rut where they had settled into the planks. The machine will then move forward easily. This method has been found very satisfactory and is a great saving both in time and in repairs over the method of pulling straight away.—["The Excavating Engineer," January, 1913].

Recent Developments in Surveying Instruments include a compass-testing device and a plane-table orienting device. These have been introduced in the topographic service of the U. S. Geological Survey, and were described by E. E. R. Tratman (Engineering News) in a paper dealing with modern designs of engineering instruments, which was read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago, Jan. 22-24. The compass device is for testing all compass needles before they are sent out for field work. It has been found, as a result of systematic tests, that many compass needles (even when received new from the maker) are deficient in magnetism. Under the new system, every compass owned by the Survey is numbered, and before it goes out for use it is tested with a standard compass. The deflection of the standard compass while swinging freely, caused by the needle under test when placed in a fixed direction and distance from it, is noted and recorded. A later test of the same needle will indicate its quality. If it is made of a poor grade of steel or is badly tempered, it will probably lose a large part of its magnetism. If the loss is excessive the needle will be replaced by a new one. After each test the needles are remagnetized by inserting them in a solenoid, after which a second test is made and recorded.

A simple device for orienting the plane-table without the use of compass needles was developed during 1912 and adopted for use in all areas where local conditions are such that variable declination may be expected. This is the D. H. Baldwin solar chart, being named after its inventor, who is a topographer of the Survey. It is based on the principle of a sun dial having a vertical gnomon or stylus. The paper chart used has on it all the data needed for laying off the proper angle for any hour of the day and for any day of any year in this century. Although on first sight the chart appears quite complicated, in practice it is found both simple and rapid. While the sun is visible the table can be oriented with it in less than the time required for a swinging compass needle to settle.

Adhesion of Old to New Concrete—A Paper by H. St. G. Robinson before the Institution of Civil Engineers in London, entitled "Experiments on the Adhesion of Old and New Concrete," set forth the results of a short set of experiments on this subject. The author tested a number of prisms of concrete as cantilevers and noted the relative efficiency of joints formed under different conditions. The standard prism to which all the others were compared was molded in one piece and four types of joints were tested, six specimens being prepared for each type. Assuming the solid prism to have an efficiency of 100%, the following were the results for the other series: (a) Face wetted only, 38.3%; (b) face roughened and wetted, 56.2%; (c) face roughened and grouted, 85.5%; (d) face treated with acid, 82%. The four types are described as follows: In "a" the faces of the seven days' old concrete which constituted the two separate parts of the prism were merely washed and well wetted prior to the imposition of new material. As these faces had been molded against the somewhat rough softwood board they were fairly open and coarse, and the somewhat high efficiency obtained with these joints is due to this roughness. In series "b" the faces were roughened with a chisel, all the loose material cleared away and the surface thoroughly wetted. In series "c" the faces were prepared first as in series "b," and then were washed over several times with a thick wash and a semiliquid cement grout, the new concrete being immediately applied. In series "d" the faces were thoroughly cleansed with water and treated with hydrochloric acid. After the acid had removed the cement to a sufficient depth to expose the aggregates and thus leave a very rough face, all traces of the acid were removed with stiff brushes and water, and the new concrete was then applied.

All the blocks were made at the same time; the artificial joints were made seven days later, and the whole set was tested 28 days after their manufacture.

Solving Quadratics by Slide-rule—A slide-rule solution for quadratic equations is given by R. W. Stewart, Engineer of Bridge Department in the City Engineer's office, Los Angeles, Calif. One of the commonest cases is that of computing tangent offsets to a circle, as in getting ordinates to an arch, and this case is taken as an example. If R is the radius of the circle, and a point on the tangent is distant x from the point of tangency, the offset y at point x to the circle is obtained from the semicircle rule:

$$y\ (2R - y) = x^2$$

which gives

$$y = \frac{x^2}{2R - y}$$

This expression can be handled by slide-rule, as follows:

Set the runner to x on the lower scale, which will give x^2 on the upper scale. Then, reading on upper scales only, shift the slide so as to make its index read y, the correct value of y being obtained when $2R - y$ appears on the slide at the runner. If greater accuracy is desired, set x^2 on the lower scale and find y here.

While this is a trial method, like the method used for extracting cube root on the slide rule, its simplicity is shown by the example quoted below.

[Continued on p. 374.]

Strength and Ductility of Iron, Steel and Bronzes at High Temperatures

The accompanying cuts show the results of two series of tests, Fig. 1 in tension and Fig. 2 in torsion, made under high-temperature conditions on some of the more common alloys by L. W. Spring and I. M. Bregowsky in the laboratory of the Crane Co., Chicago, Ill., makers of valves and steam fittings. The usual tests of such materials are made under conditions of normal temperature, say between 50° and 150° F., and do not tell what service the metals will give when hot. While the weakening effect of high temperatures has always been recognized, only few precise data have been available, particularly as regards bronzes. Such tests have been made necessary by the modern tendency in steam-engineering practice to increased boiler pressures and higher engine temperatures, due to the use of superheated steam, these advances making necessary the use of better valves and pipe-fittings.

In Table 1 are given the quantitative chemical analyses of the several alloys tested. A complete account of the

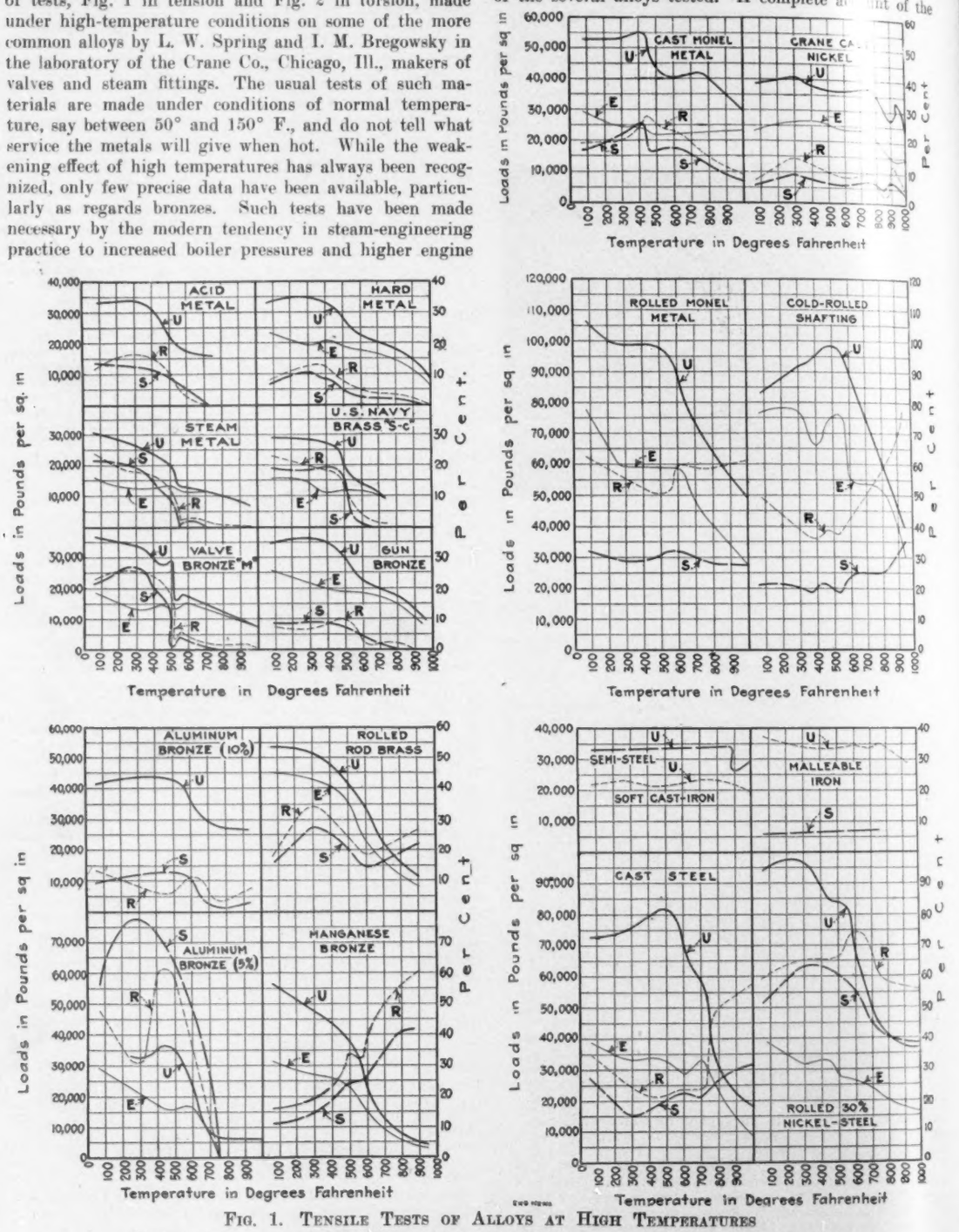


FIG. 1. TENSILE TESTS OF ALLOYS AT HIGH TEMPERATURES

(Tests by L. W. Spring and I. M. Bregowsky in the laboratory of the Crane Co., Chicago, Ill.)

U—Ultimate strength. S—Elongation.
E—Elastic limit. R—Reduction of area.

test methods and apparatus was given in a paper by Bregowsky and Spring read before the Sixth Congress of the International Association for Testing Materials at New York, September, 1912 (the paper was printed in Vol. 2, No. 13, of the *Proceedings* of the association). Another account, somewhat fuller in certain respects, but lacking the analyses, was given in the January, 1913, issue of *The Valve World* (Crane Co., publishers, Chicago, Ill.), under the title of "The Effect of High Temperatures on the Physical Properties of Some Alloys." The essential features of the tests were that the test-pieces were heated by means of an electric heating coil, that temperatures were measured by a thermometer or pyrometer placed in a hole bored longitudinally in the testpiece and extending to within a short distance of the test section, and finally that the materials tested were such as are in common commercial use rather than specially prepared alloys.

The curves are self-explanatory. They are of value mainly as an indication to the reader of the general course of the values for a given metal, and would rarely, if ever, be used for reading off accurate values of strength or ductility at a particular temperature.

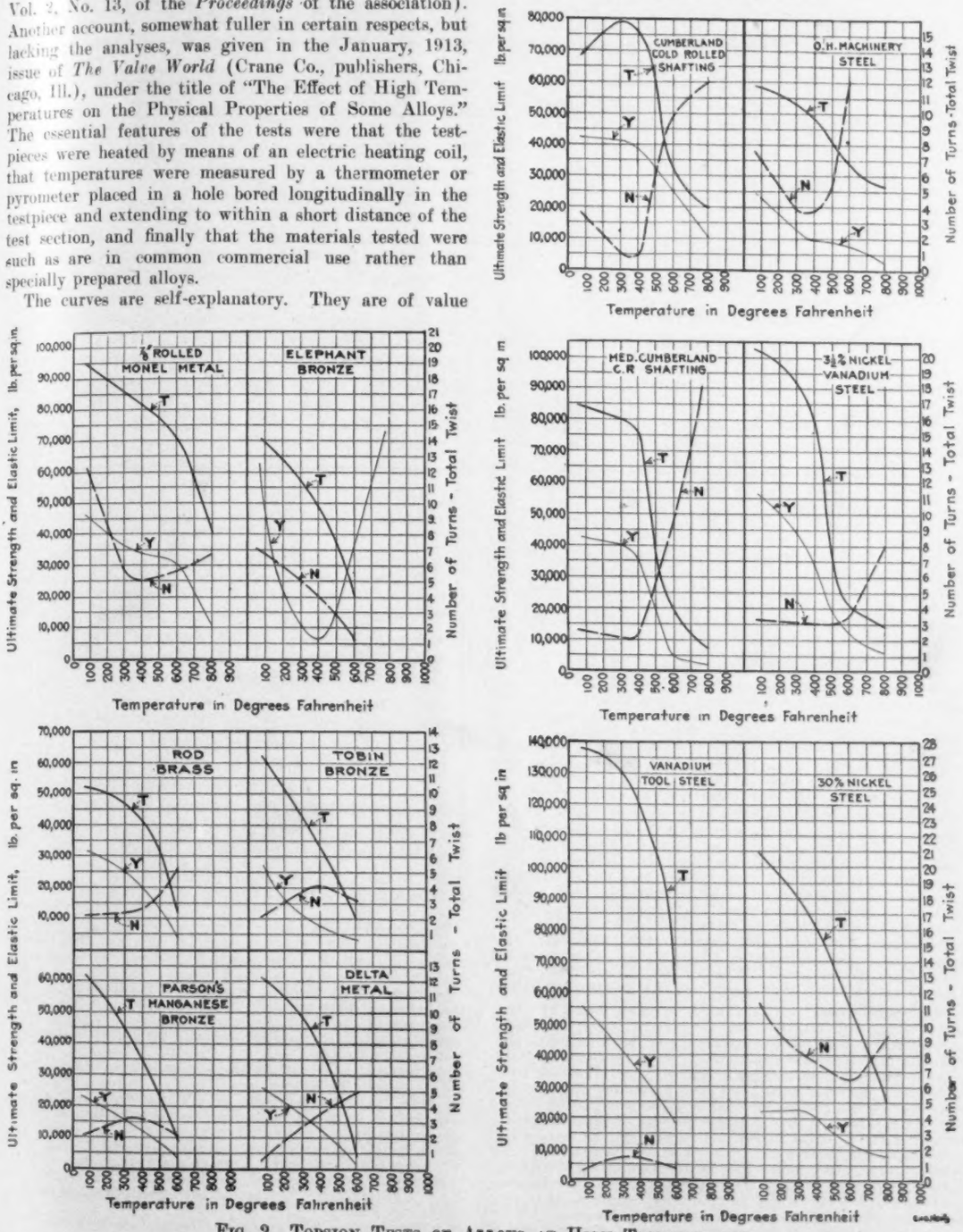


FIG. 2. TORSION TESTS OF ALLOYS AT HIGH TEMPERATURES
(Tests by L. W. Spring and I. M. Bregowsky in the laboratory of the Crane Co., Chicago, Ill.)
T—Ultimate strength, lb. per sq.in. torsional shear.
Y—Elastic limit, lb. per sq.in. torsional shear.
N—Number of turns total twist, at rupture.

TABLE 1. QUANTITATIVE ANALYSES OF ALLOYS USED IN HIGH TEMPERATURE TESTS (TESTS BY L. W. SPRIN[illegible]ND I. M. BREGOWSKY AT THE LABORATORY OF THE CRANE CO., CHICAGO, ILL.)

Analyses of metals used in tensile tests

Name	Cu	Zn	Sn	Ni	Fe	P	Pb	Mn		Al
					Percentages					
Copper-tin bronze, "Hard Metal"	87.02	0.20	12.46	.....	0.30	.....	0.06	.....		.....
Copper-tin bronze, "Acid Metal"	89.50	.....	10.22	.....	0.38	0.035	tr	.....		.....
Brass, "Steam Metal"	86.19	5.03	5.69	.....	0.20	.....	3.02	.....		.....
U. S. Navy brass, "S-C"	80.32	12.80	3.98	.....	0.24	.....	2.78	.....		.....
U. S. Navy bronze—"M", "Valve-bronze"	86.92	3.62	7.72	.....	0.23	.....	1.22	.....		.....
U. S. Navy gun-bronze—"G"	87.60	1.31	10.40	.....	0.11	.....	0.39	.....		.....
Aluminum-bronze, 10%	88.86	0.15	0.48	.....	0.75	.....	0.17	.....		.....
Rolled rod brass	62.30	34.84	.....	.....	0.15	.....	2.53	.....		9.67
Aluminum-bronze, 5%	94.94	.....	0.03	.....	0.14	.....	0.16	.....		.....
Cast manganese-bronze	58.10	39.05	0.51	.....	2.21	.....	tr	0.055		4.90
Cast monel-metal	27.11	.....	0.08	64.79	5.46	.....	0.13	2.33	0.[illegible]	.....
Rolled monel-metal	27.22	.....	.....	68.64	2.38	.....	.....	1.56	0.22[illegible]	.....
					Percentages					
	Fe	Si	Mn	S	P	C	Ni	Gr.C.	C.C	
Cast nickel*	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Cold-rolled Bessemer shafting	98.842	0.031	0.80	0.108	0.079	0.14	.....	.....	.....	
Cast-iron (Semi-steel) "Ferrosteel"	93.077	1.76	1.15	0.103	0.44	.....	.....	3.0	0.47	
Soft cast-iron	92.517	2.57	0.60	0.013	0.73	.....	.....	3.31	0.17	
Cupola malleable-iron	95.475	0.92	0.51	0.152	0.183	.....	.....	2.96	tr	
Cast-steel	98.755	0.22	0.61	0.068	0.045	0.302	.....	.....	.....	
Rolled 30% nickel-steel	65.827	0.14	2.80	0.017	0.011	0.285	3.092	.....	.....	

Analyses of metals used in torsion tests

	Cu	Zn	Sn	Ni	Fe	P	Pb	Mn	C
					Percentages				
½-in. rolled monel-metal	27.22	.....	.....	68.64	2.38	.....	.....	1.56	0.225
Elephant (phosphor) bronze	95.52	.....	3.87	.....	0.16	0.307	.....	.....	.....
Rod brass	61.08	35.72	0.18	.....	0.42	.....	2.34	.....	.....
Tobin bronze	59.86	38.94	0.80	.....	0.46	0.0015	.....	.....	.....
Parson's manganese-bronze	59.58	38.08	0.64	.....	1.22	.....	.....	0.34	.....
Delta metal	56.56	39.36	0.76	.....	2.40	0.004	.....	.....	.....
					Percentages				
	Fe	Si	Mn	S	P	C	Ni	Va	Cr
Vanadium tool steel	98.115	0.16	0.32	0.034	0.014	0.722	.....	0.145	0.49
30% nickel-steel	65.837	0.14	2.80	0.017	0.011	0.275	30.92	.....	.....
Cumberland c.-r. shafting (medium)	98.932	0.12	0.51	0.05	0.013	0.375	.....	.....	.....
Cumberland cold-rolled shafting	98.435	0.024	0.50	0.11	0.101	0.83	.....	.....	.....
3½% nickel-vanadium-steel	95.279	0.132	0.45	0.042	0.032	0.365	3.25	0.45	.....
Openhearth machinery-steel	99.36	0.024	0.49	0.029	0.013	0.084	.....	.....	.....

*Commercial nickel.

The ordinary solution of the above equation is in the regular quadratic form:

$$y^2 - 2Ry = -x^2$$

or,

$$y = R - \sqrt{R^2 - x^2}$$

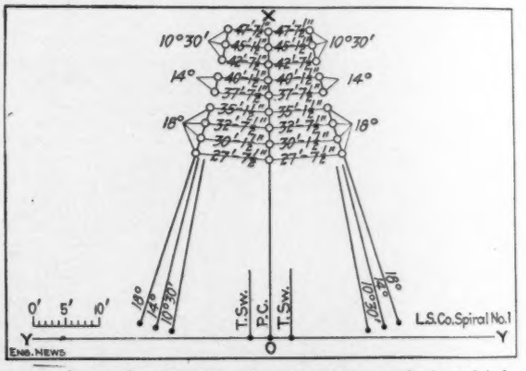
which equation can be deduced directly from a diagram of the case in hand. The use of this equation was compared with the slide-rule method in a particular case from practice.

It was required to compute the distances of the extrados of a circular arch below the crown, at a series of points 4 ft. apart, the arch having 40-ft. radius. These distances were needed to get the heights of the spandrel wall for computing the volume of the wall. Eight solutions of the problem had to be made, one for each point from 4 to 32 ft. from center of bridge. By the slide-rule method it was necessary to write down only two columns of figures, a column of x, and a column of the resulting y; if the values of x^2 should be wanted for further work they could be written down with practically no extra loss of time. Using an omnimeter—a circular slide-rule—the eight values in the example were obtained in 3 min. To get the result by the quadratic solution, five columns of figures had to be written: x, x^2, $R^2 - x^2$, $\sqrt{R^2 - x^2}$, and y; two columns involve subtraction, and two either squaring or extracting a square root. The time required for this solution is not stated except to say that it was considerably over the 3 min. required by the recommended method. In both cases the results were read to two decimal places (e.g., y = 11.43 ft. for x = 28 ft.).

The method is applicable without change to other examples involving quadratic equations. Very likely some degree of practice must be had before the eye can read simultaneous values of y and K — y at the two points on the slide.

The "Spiralgraph"—W. T. Rossell, Jr., Asst. Engr. of Roadways, Cincinnati Traction Co., Cincinnati, Ohio, describes a new instrument which proves of great assistance in laying out spiraled street-railway curves. It is essentially a template giving the center of main curve, point of spiral, point of tangent, etc. By using two such templates (for the two ends of a curve), the layout can be tried with various spirals and various radii in the shortest possible time and without making a mark on the paper, and as soon as the best spiral-and-curve combination has been selected the centers and other determinative points can be marked through onto the drawing and thus the layout completed. The actual drawing of the transition curve may be done by a template cut to that particular curve on the scale used for the drawing.

The "spiralgraph" is shown diagramatically by the sketch herewith, representing the Lorain Steel Co.'s spiral No. 1 drawn (in the original) for a scale of ¼ in. to 1 ft. The figure is supposed to show a rectangular sheet of celluloid or metal, on which the lines and figures indicated have been scribed with a sharp point. The circles indicate holes drilled through the sheet. They mark the centers of curves of various radii combined with various spirals, and also for each case the P. S. C.; the P. T. is in the middle, at the intersection of OX and YY, and to either side the position of toe of switch is marked. The open circles, which are the curve centers, are holes which receive a bolt with a very thin flat head and a hole drilled through its axis. By means of this bolt



two such templates can be pinned together and pivoted independently about the same center, providing for the two ends of a curve.

For curves not spiraled the holes on the line OX are used. the holes to right and left of axis OX indicate the centers of curves of the radii indicated in feet and inches, for a length of spiral whose total angle is indicated by the figure just outside (10° 30′, 14°, 18°).

In using the instrument the two tangents between which the curve is to be laid out are drawn. Suppose a trial radius of 40 ft. 1½ in. is selected. Insert the small bolt through hole marked 40 ft. 1½ in. in both templates (right-hand hole in one, left-hand hole in the other), and set the axis YY of each template on one of the two tangents as laid out. Then prick the center of curve through the hole in the bolt, the P. S. C. through the hole at the end of line marked 14°, and if for a switch spiral the toe of the switch through the hole marked T. Sw.

It will be seen that a pair of templates (both alike) is required for each spiral. These "spiralgraphs" are used in the engineer's office of the Cincinnati Traction Co. It is claimed that accurate results can be obtained at a great saving of time.

EDITORIALS

The United States as a Shipbuilding Nation

There is a widespread popular impression in this country that the shipbuilding industry in the United States is trifling in importance compared with that of European nations. Probably few outside of those interested in the shipping business are aware that only two nations in the world, Great Britain and Germany, surpass the United States in the magnitude of their shipbuilding industry.

Tables from *Lloyd's Register,* published in London *Engineering* of Jan. 24, summarizing the statistics of shipbuilding in various countries of the world during the past fifteen years, show that in the year 1912 the tonnage of vessels of 100 tons gross measurement and upward launched in the United States was 284,223 tons. In the same year German shipbuilders launched vessels aggregating 375,317 tons, and French shipbuilders, who take the fourth place, launched only 110,000 tons. Of course, Great Britain is the chief shipbuilding country of the world. The total tonnage turned out of her shipyards in 1912 amounted to 1,738,514 tons, which was considerably more than the output of all other nations combined.

All the above figures, it should be said, are for merchant vessels alone. With war vessels included, the United States tonnage for 1912 was 349,500 tons. The relative position of the principal nations in shipbuilding is not changed by the inclusion of war vessels. With respect to the relative output of the United States and Germany, it should be noted that no longer ago than 1910 the present position of the two nations was reversed, the United States launching in that year vessels aggregating 331,318 tons and Germany only 159,303 tons.

It may be well to point out that American shipbuilding under present economic and industrial conditions is confined almost exclusively to the supply of vessels for coastwise and inland navigation and for the Navy. Under present economic and industrial conditions American shipbuilders appear to be unable to compete with their European rivals for vessels to operate in international trade. Of the output of the United States in 1912, the Lake shipyards launched 90,000 tons.

⁂

Two Ways of Obtaining Efficiency

The New York State Investigating Commission, which at Governor Sulzer's direction is overhauling the methods of work followed by various departments of the New York State government, has drafted a bill to create a new State Department of Efficiency and Economy. It is currently reported that the head of this commission is to have a salary of $12,000 a year and that a prominent politician is slated for this appointment as a balm for his disappointment because he did not receive a high place on the Public Service Commission.

Far be it from us to say one word in the way of any movement whatever which even aims to produce efficiency in governmental affairs. Better this than nothing. We are strongly impressed, however, that this is the wrong way to set about the production of genuine efficiency and that the error is a fundamental one, which is working serious harm in private business as well as in public business.

The right way to produce efficiency is to select men for responsible positions who are competent for their work. If Governor Sulzer, or any other Governor of New York or any other State, appoints at the head of State departments in charge of important public business, men whose political activity is the reason for their appointment and who know nothing about the work which they are supposed to supervise, a Commission on Efficiency and Economy, or one labeled with any other name of excellent sound, can do very little to help the situation.

What Chief Engineer of a large construction enterprise would be willing to take the responsibility for the work if the division engineers, and superintendents, and foremen under him were distinguished by various degrees of incompetence and he had to rely on a floating gang of accountants and cost-keeping experts and methodizers to show these men how to perform their work? What army in a campaign could win battles if its commanding generals were incompetent, even though a staff of inspecting generals were sent out by the War Department to tell the commanders wherein they fell short?

In saying this we are by no means denying that there is a certain field of usefulness for the so called "efficiency engineer" (a term to which we strongly object), provided he adds to his knowledge of methods of management and organization a large fund of common sense. We are far from denying that in some, or perhaps many, industrial plants, such an engineer can make valuable suggestions for improvement. In many concerns permeated with dry rot he may indeed work a real revolution in methods of production.

What we do protest against is the too prevalent idea that efficiency engineers or efficiency commissions can in any way obviate the necessity of having able men in important and responsible positions if efficiency is to be secured.

⁂

Cases Where Engineering Judgment Differs

All young engineers (and some old engineers) need to realize that of many engineering problems two or more perfectly correct solutions are possible. It happens not infrequently that the decision as to which solution will be accepted may depend more upon the temperament and taste of the engineer in responsible charge than it will upon the local circumstances and conditions.

One of the best illustrations of this fact is the differences in engineering practice of different countries. Take, for example, the typical differences in railway roll-

ing stock of England and the United States. English railway shops do things, and have been doing them successfully for many years, which many shopmen in this country would declare to be the extreme of bad practice. The converse is equally true.

Another example is the typical differences in bridge practice of the two countries. English bridge builders have a great fondness for bowstring trusses. Both English and Continental builders have no hesitation in adopting curved lines in their truss designs, while American builders stick closely to the rectilinear truss.

A remarkable illustration of how practice may diverge on opposite sides of the ocean is furnished by an article in *The Engineer*, of London, in its issue of Dec. 20, describing the new water-supply for the city of Leicester, England. This water-supply is collected in the Derwent Valley and is carried a distance of about 30 miles to the city of Leicester in two cast-iron mains 35½ in. in diameter. Where this pipe line crosses the Trent River the crossing is made by means of a bridge of 220 ft. clear span.

The puzzling question is why this line of conduits was carried over the stream on a bridge instead of laying the pipes beneath the river bed. The bridge was built especially for the pipe line, and carries nothing else save a footway. Instead of carrying the cast-iron mains across the bridge, 30-in. steel mains are substituted. They are supported on cast-iron rollers to allow free movement and a difficult and expensive bend had to be made at each end of the bridge to bring the pipe up out of the ground to the level of the bridge. The bridge is far from being an inexpensive one to construct, for it is supported on cylinder piers, which had to be carried down 22 ft. below water level, with the aid of compressed air, to reach a safe foundation. The river at this point is navigable and the bridge had to be placed 17 ft. above water level. This, of course, limits the height of vessels passing under it.

As far as one is able to judge from the published description, the conditions in all respects are such that any American engineer who had the responsibility of solving this problem would have, without question, placed his conduits underneath the river bed, instead of carrying them across overhead. Why the other solution was adopted by the English engineers is a question on which our contemporary's description sheds not a particle of light.

The same article, however, contains an even more difficult puzzle to the American engineer. It became necessary at a certain point to carry the conduit line across a single-track railway. Instead of tunneling through the embankment beneath the tracks, and laying the pipes there, the engineers constructed two enormous bends on each side of the railway, and built two high brick piers to carry the mains across over the track. This was rather a bold piece of engineering work, for the pipes are, according to the description and drawings, unsupported in any way, and the distance between the masonry piers is 33 ft. c. to c. It is true the railway was in a cutting at this point, so that a depression in the pipes would have been necessary to have passed under the railway, but the depression required would have been much less than the elevation which is necessary to carry the pipes overhead and give them proper clearance.

Perhaps the English engineers responsible for this design were concerned lest the load upon the pipes from the trains passing overhead, if the pipes had been carried underneath the track, might cause eventual fracture. An American engineer would have been far more concerned as to the stability of a 30-ft. span of pipe only 30-in. in diameter and carrying a load of water under heavy pressure. To make the whole matter still more puzzling, *The Engineer* says that this railway crossing is typical of the various brook crossings along the pipe line. We shall not attempt to fathom the mystery why the engineers who built this pipe line preferred to carry it overhead instead of underneath every brook and railway and river which it crosses. We merely present the fact as illustrating the principle that of many engineering problems more than one successful solution is possible.

We cannot refrain, however, from calling attention to the further fact that the whole matter is illustrative of a common and serious fault in engineering literature. We believe it is far more important to the engineer who reads engineering literature for its practical usefulness, to find out *why* a thing was done than *what* was done. Every piece of engineering work can be considered as made up of the solution of a number of problems. In order that an engineer shall reap the greatest benefit from the study of the work which other engineers have done, he must know what were the conditions which were involved in the problems that were solved and what were the reasons which governed the engineer in choosing one solution instead of another.

A New England Scheme for State Supervision of Railway Operation

It is pretty well known that Massachusetts led all the other states in the Union in the establishment of government supervision of railway operation through a State Railroad Commission. A conference of the Governors of the New England States, held in Boston, Jan. 25, may have ultimately as large results in the development of government control over railway operations as did the original Massachusetts Railroad Commission established 45 years ago, or as did the establishment six years ago, by Governor Hughes of New York, of the first State Public Service Commission.

Some months ago, when the agitation broke loose in New England over the projected alliance between the New Haven and Grand Trunk interests, we referred to the affair as a tempest in a teapot. We did this in view of the comparatively unimportant nature of the transaction which started the hubbub. We did not believe and do not believe that the extensions of the Grand Trunk system to Providence and Boston were of any such vast importance to New England commercial welfare as was claimed. In fact, if an absolutely impartial commission, having the public welfare as its sole object in view, had to pass upon the question whether public convenience and necessity demanded the investment of this additional amount of capital in railway lines in New England, we very much doubt whether the verdict would be an affirmative one.

It has become evident, however, from the continued agitation of the past three or four months, that the question at issue in New England is a larger one than the mere matter of bringing in to Boston and to Providence the Grand Trunk Ry. system as an independent

competitor. New England has suddenly aroused to the fact that its entire railway system is under the control of a single corporation, and an overwhelming indictment of this corporation's control and management has been rolled up from many quarters. To what extent this indictment is justified by the facts, we shall not at all attempt to say; but it is certain that from Maine to Connecticut, and from Rhode Island to Vermont a chorus of complaints has arisen. It is evident that the public is not by any means satisfied with the measure of state control over railway operations which the present railway commissions in the New England States exercise. There has been evidence, also, of a pretty widespread public demand that the State of Massachusetts should purchase the whole of or an interest in the New England railway lines, and this demand has been voiced not merely by the large and growing element of the population which is inclined toward socialist views, but by many usually conservative business men. It has been common enough to hear the remark, "I don't believe in state ownership of railroads, but I am in favor of state ownership of the New Haven R.R."

Of course, sober second thought indicates at once the enormous difficulties which would stand in the way of half a dozen states sharing in the ownership and control of a great railway system supplying the transportation requirements of them all.

It should also occur to many of the advocates of state ownership that if a private corporation, with every incentive to economy and unhampered by the laws and red tape inseparable from government ownership, can barely earn operating expenses (as is the case on a large proportion of New England railway mileage), then government ownership and operation of these railway lines would evidently place a heavy burden on the taxpayers to make up the deficiency.

It is not to be expected, either, that conservative New England would undertake to confiscate the railway lines within its borders; and to create an enormous public debt in order to purchase the whole or a part of these railway lines would hardly meet with popular approval.

It has been demonstrated, however, that there are difficulties in the exercise of control by the Railway Commission of a single state over a railway corporation operating lines in half a dozen states. There appears to be also an overwhelming sentiment among New England business men that a larger measure of public control should be exercised over the railways which serve them.

It was in recognition of this popular sentiment that a conference of New England governors was held at Boston, on Jan. 25. At this conference it was agreed that the governor of each state should appoint two citizens of his state to be members of a New England Railroad Conference, to consider and report on the best modes of developing and operating the New England railroad system. The New England Railroad Conference thus constituted is to consider a dozen or more subjects. One of them is defined as follows:

> The question of creating state directors representing the various New England States in the management of the railroad system and the general question of the participation of the public in the ownership or operation of transportation facilities and the form of such participation.

There has been some public discussion of this proposition already, and more is likely to be heard in the future. The proposal to represent the public interest in the efficient management of railways by having some members of the Board of Directors appointed by public authority is not entirely novel. Over 20 years ago it was suggested in a treatise on monopolies and their control, written by a member of the editorial staff of this journal. At even an earlier date it was in actual operation in the Union Pacific R.R. Co. For many years the financial interest of the United States in that railway was recognized through the appointment by the President of the United States of a member of the Board of Directors to represent the government's interest. It is our impression that the men who served as government directors of the Union Pacific in those days were men more distinguished for political activity than for their knowledge of railway finance and management. Unless we are greatly mistaken, the government directorship of the Union Pacific Co. became simply an opportunity for the President to provide a comfortable berth for some superannuated politician.

Of course it is easily among the possibilities that if it were attempted to effect government control of railways at present by appointing directors to represent the state or the federal government, these directors might either be amiable figureheads or active blackmailers.

This, however, is really no argument against the proposition. Exactly the same thing is true of the men who may be appointed as members of State Railway Commissions or Public Service Commissions. In other words, it is an absolute essential of successful state control of public utilities that the men selected to administer such control shall be in the first place honest, and in the second place competent. These two things are essential, no matter how much or how little authority these men may be given and regardless of the particular way in which the authority may be exercised.

It is universally agreed at the present day, even by the officers of public-utility companies, that public control over them has come to stay. The practical question is how may this control be most effectively exercised?

The present tendency in the public-service commissions where control has been most highly developed, as in the states of New York and Wisconsin, is toward the establishment of a system of inspection and supervision of the detailed operations of the various railway and other public-utility companies.

This is, in some respects, commendable, but there is a limit beyond which it is not wise to go. To attempt to inspect and supervise every department of railway operation by state officials has a tendency to harass staff and employees and create friction and irritation on both sides. Moreover the expense involved in such detailed supervision is so great as to make it of doubtful wisdom even if it were possible to carry it out in an ideal manner.

We have recently discussed the overloading of the Interstate Commerce Commission with a multitude of new duties. The same thing is being experienced by the State Public Service Commissions and will grow more serious as year by year new details of operation are committed to these commissions' control.

While in the theory of the public-service commission law the three, or five, or seven commissioners are supposed to personally exercise their large powers of control, they are actually merely the executive heads of a great organization of engineers, accountants, inspectors, etc.

There is danger that this system will tend to break

down by its own weight. We must not forget that there are limits to what such public supervision can accomplish.

The situation is not wholly unlike that existing in City Building Departments, which has been more than once discussed in these columns. We have pointed out the error in supposing that the force of municipal building inspectors in any city can so thoroughly supervise all the construction work going on as to make it unnecessary for the owners of buildings under construction to employ their own supervisors. We have shown that in no case must the inspection of the City Building Department be held to relieve the owner and architect of a building under construction from the primary responsibility that the construction is safe and properly carried out.

In like manner the supervision of a State Public Service Commission over the operations of a railway or a gas company ought not to extend to such details of inspection and supervision as to relieve the corporation itself and its officers and employees from its responsibility for furnishing good service at reasonable rates and devoting energy and efficiency to this work.

Bearing these things in mind, it is an interesting question whether the public demand for the further extension of government control over public utilities might not be better met by representation on the Board of Directors of public-utility corporations than by adding detailed duties to the present Public Service Commissions. There is no reason, so far as we can see, why the two methods of control might not exist together.

Of course, the objection to this method of control which will be at once heard will be that the directors appointed to represent the state would not represent the owners of the property, as do the directors elected by the stockholders. It would not be hard to recall many cases, however, where the interest of the owners of a corporation's bonds and stocks would have been better protected by state directors than by the directors put in office by the financial interest in control. If we could always have such men as Governor Hughes of New York at the head of our state governments, we fancy that the majority of holders of stocks and bonds would rather trust their interests in the hands of directors appointed by the governor than in the hands of the directors selected by the controlling financial interest at whose behest they fill out proxies year by year.

The selection of the directors who control the great life insurance companies, with their billions of dollars of accumulated capital, the property of a million stockholders scattered all over the country, is in the hands of a few men in New York City. It has been demonstrated to be a practical impossibility for the policyholders to exert any real voice in the selection of the men who control this enormous wealth. The same thing is true of most of the great railway and industrial corporations, with their stocks scattered in the hands of many thousand holders. A few men owning a very small part of the property can manage the whole as they please, and the stockholders are practically powerless to change the situation.

State control of public utilities through Public Service Commissions has been established primarily to protect the interests of the public. We believe state representation on the directorate of public-utility companies is equally needed to protect the stock and bondholders who are the owners of the property from spoliation at the hands of the interests in control.

Of course, we are speaking broadly, with full knowledge that many corporations are honestly managed, with full regard for the interests of those who hold the corporation's securities; but the exceptions to this have been so many and so flagrant in the past twenty years that no legislation looking to better administration of public utilities can ignore this aspect of the question.

It may be said, of course, that one, or two, or three state directors on the board of a corporation would be in a minority and could therefore always be out-voted by the directors elected in the ordinary way. It does not follow, however, that these directors would not serve a very useful purpose, provided, of course, that they were men of the requisite ability, force of character and honesty. At least, they would be in a position to give publicity to nefarious schemes concocted to defraud the stockholders or aimed against the public interest.

It is worthy of note that steps tending in this direction have already been taken in a number of different cities. In both Chicago and Philadelphia, the systems of street transportation are now under the joint control of representatives of the city and representatives of the owning companies. There have been a few instances also of joint ownership and joint control of such public utilities as water-works and gas-works by a private company and the city.

It is indeed worth consideration whether an extension of this principle may not eventually be made a means of exercising a certain amount of public control over a long list of industrial and commercial enterprises. In our banking system, for example, the federal government inspectors usually become aware of the looting of a bank by those who control it only after the event has taken place. This is a sample of a great deal of government supervision and inspection which only succeeds in locking the stable door after the horse has been stolen. There are strong arguments to be made, therefore, in favor of a government supervision, which can be exercised from the inside instead of the outside.

We fully appreciate the very great difficulties in carrying into effect the principle which we have outlined above. In the several states of New England, for example, it may be argued that the directors from each state should have a voice only over the railway operations within the limits of that state. In railway operations it often happens also that the interests of one locality will be opposed to those of another locality. Perhaps it was this reason which caused the governor of Maine to remain absent from the Boston conference. Maine would rather see the United States terminal of the Grand Trunk system remain at Portland than to have new terminals for Canadian traffic developed at Boston and Providence.

These and other difficulties will in all probability prevent the plan of controlling public utilities by state-appointed directors from coming into use for a long time in the future. We believe, nevertheless, that it deserves the consideration of candid and thoughtful men. Those who best understand the magnitude of the great forces which are tending toward social upheaval, realize that the only means by which this threatening wave can be made to spend its force without destruction is by taking radical steps (or steps that would have seemed radical a generation ago) for the betterment of conditions in our economic, industrial and political life whose evil results are admitted by all.

LETTERS TO THE EDITOR

Anti-typhoid Vaccination among U. S. Reclamation Service Engineers

SIR: Some thirty engineers and assistants of the U. S. Reclamation Service, on the Sun River Project, Montana, are being vaccinated against typhoid fever. Three doses were given, ten days apart. The first and second doses were of 0.5 c.c. of serum, containing approximately 500,000 dead typhoid germs. The third dose was of 1 c.c. and contained 1,000,000 organisms. The effects of the treatment are mild, a slight fever resulting for the next forty-eight hours after treatment, and the arm is lame and sore for about three days. The serum is furnished free by the Reclamation Service and is secured by them at the Army Medical School at Washington, D. C.

This vaccination is taken simply as a precautionary measure. This part of Montana is very healthful and typhoid fever is rare. It is probable that a large amount of construction will be in progress on the Project during the coming year and the various engineers and assistants will be located near large camps of men where it will be difficult to control sanitary conditions. The summer season is hot and dry and flies are very numerous around camps on the open prairie.

WALTER S. MERRILL.

U. S. Reclamation Service, Fort Shaw, Mont., Feb. 10, 1913.

Street Traffic Counts in Newark, N. J.

Sir—The City Plan Commission of Newark, N. J., has had traffice counts taken throughout the city along lines similar to those suggested in an article entitled, "A Proposed Standard Record of Street Traffic," which appeared in ENGINEERING NEWS of Jan. 2, 1913.

The results, in the case of Broad St., were somewhat at variance with those given in the aforesaid article, probably due to the fact that our count is much more recent. Market St., rather than Bridge St., is Newark's second busiest thoroughfare. Our results were as follows:

	Totals on whole width of roadway		Totals per yard effective width of roadway	
	Vehicles	Tons	Vehicles	Tons
Broad St.....	4052	7505	188	348
Market St.....	2277	4570	167	334

Considering the rapid growth in the use of motor trucks for transportation, would it not be wise to specify weights singly for runabouts, touring cars and motor trucks as well as for one-horse, two-horse and three- or more horse vehicles? The motor will very soon replace the horse almost entirely, and an average of 1.75 tons for all motor vehicles, as is suggested, will be unfair, especially upon streets which are located in manufacturing districts, as compared with a parkway for pleasure vehicles only.

HARLAND BARTHOLOMEW,
Asst. Engr. City Plan Commission.

Newark, N. J., Jan. 10, 1913.

Progress on the Richmond, Calif., Port Project

Sir—Since your receipt of the information upon which was based the article entitled "The Proposed Port of Richmond, Calif.," in your issue of Jan. 23, 1913, p. 145, the following progress in the project has been made:

Our report and plans were adopted by the city trustees on Sept. 23, 1912, and detailed contract and specifications for the highway and tunnel portions of the project were approved on Nov. 18, 1912. The matter was submitted to the electors on Nov. 19, 1912, under two segregations. The vote in favor of the tunnel and highway portion for a bond issue of $440,000 was approved by a vote of somewhat over 5 to 1. The vote on the second unit for $730,000 bonds, bonds for wharf construction, was approved by a vote approximately 8 to 1. The legality of the bonds has been passed upon and they are now offered for sale, the first unit of $350,000 on Feb. 10. We are now preparing detailed plans, with the expectation of starting construction work immediately.

HAVILAND & TIBBETTS,
By FRED H. TIBBETTS.

San Francisco, Calif., Feb. 4, 1913.

The Clifton Suspension Bridge

Sir—In regard to the very interesting article on the Clifton suspension bridge (at Bristol, England) in your issue of Jan. 30, I am sending you some additional notes relating to this bridge. The $5000 bequeathed in 1753 by William Vick was to be kept until it had increased to $50,000, and it was then to be used for building a stone bridge. When the project was first started in 1829, Thomas Telford was the engineer, and his plans showed a suspension bridge in three spans, with two tall stone towers 400 ft. apart, c. to c., rising from the valley. His original estimate for the work, which was confirmed by Mr. Brunel, was $260,000. On account of difficulty from foundations on the west side, Mr. Brunel intended at first to put that tower 260 ft. further back, making a span of 960 ft., but in this he was overruled by the directors of the company, and an abutment of enormous size was therefore built further out toward the valley. The abutments are not at the same level, one being 3 ft. higher than the other, and the system of hangers is unsymmetrical on each side of the span center. During the first period of construction, in addition to building the abutments, anchorages in the solid rock were also prepared for the chains. Vertical shafts were sunk 233 ft. back from the tower centers, to intersect the anchor chambers (at a depth of 53 ft. below the surface), which are inclined at an angle of 45° with the horizontal. Prior to 1853, when work was abandoned, no less than $225,000 had been expended.

The Hungerford suspension bridge over the Thames at London (at Charing Cross), built during 1841-45, under the direction of Mr. Brunel, had a center span of 676½

ft. and side spans of 333 ft. It was 14 ft. wide and was for pedestrian travel only. The towers, in Italian style, were 22 ft. square, of brick masonry, rising to a height of 58 ft. above the roadway. The total cost of the bridge was $550,000. The chains consisted of two sets of links, one above the other, at each side of the bridge, the pins of one set being midway between those of the other. The floor suspenders were attached to triangular levers or crossheads, which in turn hung by two rods from the upper and lower chains, attaching to the pins in one case, and hanging on the other chain from the middle of the bars, producing bending therein.

In 1861, the old Hungerford bridge was bought by the Charing Cross Ry. in order that it might be replaced by a heavier structure leading to the new Charing Cross railway terminal, and the parts of the old bridge were therefore for sale. By a strange coincidence, negotiations were being conducted simultaneously by two sets of men for the completion of the Clifton bridge; John Hawkshaw was purchasing the old chains from the railway company at London, while W. H. Barlow was at the same time buying the piers, land and approaches from the trustees of the Clifton bridge. As each of these men is said to have known nothing of the other's doings, the work was carried on jointly by Hawkshaw and Barlow. The principal features of the Hungerford and Clifton bridges are given in the accompanying table:

HUNGERFORD AND CLIFTON SUSPENSION BRIDGES

	Hungerford	Clifton
Height of abutments above water	80 ft.	257 ft.
Span between tower centers	676½ ft.	702½ ft.
Chain deflection	50 ft.	70 ft.
Length of each link	24 ft.	24 ft.
Weight of each link	550 lb.	550 lb.
Diameter of connection pins	4¼ in.	4¼ in.
Total number of links	2600	3636
Total weight of links	715 tons	1000 tons
No. of links in center span	1280	1981
Weight of links in center span	352 tons	544 tons
Width of platform	14 ft.	31 ft.
Section of chains at center	296 sq.in.	440 sq.in.
Section of chain at towers	312 sq.in.	481 sq.in.

The land, towers, approaches and other completed work were bought for $10,000 and the old chains for $30,000. The Hungerford bridge was a narrow one for pedestrian travel only, while that at Clifton was designed for both foot passengers and vehicles. Both of these bridges were quite different in one respect from former bridges of the same class; the chains of others always had a uniform number of links, necessitating short couplings with a double number of joints. At Hungerford and Clifton, the number of links varies alternately, being 11 and 12 near the span center, and 12 and 13 near the piers, thus avoiding much extra expense for pins and couplings. The chains have the same angle of inclination at each side of the towers, and the floor is supported (as described in your article) from the successive connection pins of the three chains, thus avoiding the objectionable feature in the Hungerford bridge, of suspending them alternately on the middle of the tension bars, which caused heavy bending therein. The chains bear at the towers on 50 cast-steel rollers, 4 in. in diameter and 2 ft. long, supported on cast-iron roller plates 7 ft. wide and 14½ ft. long, thus allowing the saddles to move 18 in. each way. To support the third or upper cables on each side, other saddles were mounted on the original ones.

The method of stiffening the floor, as given and illustrated in official reports printed shortly after its completion, does not agree with that described in ENGINEERING NEWS of Jan. 30, for the reports stated that the stiffening members are lattice trusses 5 ft. deep, between the road and walks, and are similar to those at the outside of the footwalks, though heavier. Drawings show upper and lower chords composed of angles and plates connected by a system of diagonals 10½ in. apart, and supported at intervals of 2½ ft. by 3-in. vertical channels. The claim was also made that lattice trusses were a new feature, though they had been proposed several years before by P. W. Barlow. [Our description was correct, see note below.—EDITOR.] The floor-beams are 7½ ft. apart, 18 in. deep at the center, with lattice webs, and the chords have an area of only 4½ in. These floor-beams directly support the plank flooring, which is laid longitudinally and jointed with $2 \times \frac{5}{16}$-in. hoop-iron tongues.

The cost of the completed bridge was as follows: Original expenditure, $225,000; old chains from Hungerford bridge, $30,000; erection and completion of superstructure, including freight, etc., $135,000; total, $390,000. This does not include the $10,000 paid to the bridge company for the old completed work and land, nor any engineering fees.

H. G. TYRRELL.

Evanston, Ill., Feb. 4, 1913.

[In regard to the additional stiffening trusses referred to by our correspondent, these do not exist, as may be seen from the view in Fig. 1 (p. 192, Jan. 30), and as we know from personal acquaintance with the bridge. The lattice trusses are at the outer edges of the sidewalks. The suspenders or hangers are attached to plate girders, which separate the roadway from the sidewalks, but which extend only about 2 ft. above the floor. The proposed trusses were probably included in some of the preliminary designs.—EDITOR.]

NOTES AND QUERIES

In the article entitled "Concrete Dikes and Bank Protection on the Missouri River," by Maj. E. H. Schulz, U. S. A. ("Eng. News," Dec. 26, 1912), the final table of costs on p. 1200 contained some errors that make its reprinting in correct form desirable.

a. Willow Mattress.		
757 cords brush @ $0.892	$675.87	
776 cu.yd. ballast @ $0.746	579.09	
555 cu.yd. spalls @ $0.702	389.70	
Wire strand, clips	204.43	
Towboat service	784.00	
Labor, superintendence and miscellaneous	2669.59	$5,302.68
b. Concrete paving.		
1156 cu.yd. gravel @ $1.533	$1772.35	
Grading bank, 1000 lin.ft. @ $0.94607	946.07	
Reinforcement	749.32	
821¼ bbl. Portland cement @ $1.15	945.01	
Labor, superintendence and miscellaneous	1881.33	6,294.08
c. Flexible concrete blocks.		
120 cu.yd. gravel @ $1.533	$183.96	
Reinforcement	221.65	
182 bbl. Portland cement @ $1.15	209.30	
Labor, etc. making blocks	636.00	
Labor, etc. placing blocks	685.12	1,936.03
Summary.		
Weaving and ballasting mattress 1030 lin.ft. @ $5.1482	.....	5,302.68
Concrete paving and grading, 1000 lin.ft. @ $6.294	.....	6,294.08
Flexible concrete blocks in place	.....	1,936.03
		$13,532.79

The note on the "Government Stream Gaging Work," on page 303 of our issue of Feb. 13, was taken from an address by C. E. Grunsky, before the San Francisco Association of Members of the American Society of Civil Engineers. Credit to this source was accidentally omitted in printing the item.

The Recent Derailments on the Chicago Elevated Loop

Two derailments on the loop line of the Chicago elevated railways, in the business district, were described in our issues of Jan. 16 and 23, and as a result of these accidents the Commissioner of Public Works appointed a board of investigation, composed of Wm. Artingstall, G. B. Robinson and S. Gold. They had the derailed car of the first accident examined by R. W. Hunt & Co., but as this car had been dismantled the examination was not of much value, although the wheels were found to be of proper gage, with full flanges and very little wear. The track conditions were examined by A. K. Shurtleff (C., R. I. & P. R.R.), whose report is noted below. The conclusions arrived at by the board were that the first accident was due to excessive speed of the train on the curve (95 ft. center-line radius), while the second was due to faulty position of the guard rail. We give below, in condensed form, the summary and recommendations of the report.

Report of Investigations

Derailment at Van Buren St. and Fifth Ave., Jan. 8—The rear truck of the last car left the track at the middle frog, and the train traveled approximately 250 ft. before being brought to a stop. The rear car probably hung for an instant on the cross-girder (projecting beyond the track girders), then uncoupled and fell to the street, front end first. The front truck was left standing on the track. The wheels and trucks were in good shape; the flanges were full and showed but little wear. The center bearings were dry and slightly rusty, where they should have been smooth and dry. The track was in good shape, having been relaid lately with 90-lb. rails. The frog was in fair shape and good for several months' wear; it has been replaced with a new frog since the accident.* Excessive speed while rounding the curve was responsible for the accident, and the motorman was reckless and violated the rules. Statements by three unbiased witnesses estimated the speed at 8 to 12 m.p.h. The conductor did all he could to stop the train as soon as he felt the first jar. The trainman was negligent in not being in his proper place, and in not pulling the emergency cord when he felt the first shock. The track plan at this point is shown in the accompanying cut.

Derailment at Wabash Ave. and Van Buren St., Jan. 15—The wheels of the rear truck left the track at the north frog of a new crossing that had been installed only two days.† The speed was moderate, and the car was stopped within 30 ft. from the point of derailment. Lack of sufficient clearance from back to back of wheel flange between the inside guard rails of the curve was the immediate cause of the accident. This lack of clearance was due to improper curvature of the frog guard. This error was reported to the railway company and has since been corrected.

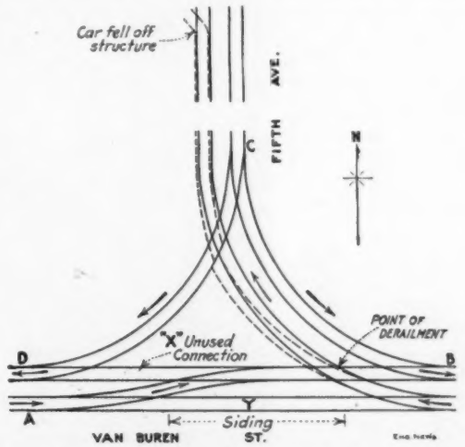
*The report of the railway company's engineer states that the crossing frog was of cast manganese construction (corresponding to 80-lb. rails) and very rigid, with the guard and running section cast in one piece. But although this was renewed, the report of Mr. Shurtleff (noted later) states that an inspection of this new crossing showed conditions of gage and guard-rail spacing that would tend to cause derailment, particularly at the west frog of the crossing.

†The situation is identical with that of the crossing shown in the cut, supposing the cut turned sideways so that Van Buren St. would correspond with Wabash Ave. (running north and south). The derailment was at the frog corresponding to that shown in the cut, but the car ran only a short distance into the triangular space between the tracks.

Recommendations—I. A maximum speed not to exceed 8 m.p.h. at all curves and crossings where it is not feasible to provide superelevation; 2, where there is superelevation, the maximum speed to be determined by the amount of superelevation and the degree of curve; 3, operation of motors in multiple to be forbidden while the train is on the curve; 4, targets to be placed on the tangent to indicate when the last car has cleared the curve; 5, special guard rails at all curves; 6, struts and ties to be provided to hold all running and guard rails in proper relation to each other.

Report of A. K. Shurtleff

The first part of this report discusses the action of wheels and trucks on curves, and the purpose of superelevation of rails, such superelevation being of necessity



Corner of the Elevated Loop in Chicago, Where a Derailment Occurred Jan. 8

1. The dotted lines show the path of the derailed truck.
2. Trains of the Oak Park and Northwestern lines run north on the outer track of the loop.
3. Trains of the Metropolitan line enter the inner track of the loop at A-B and leave it by the curve C-D.
4. Trains of the South Side line follow the inner track of the loop on curve C-B.
5. The two connecting portions of the track at X and Y are not used by trains.

omitted in this case owing to the track crossing. The most significant part of his report is abstracted below. This should be considered carefully by engineers of local lines having very sharp curves, and should lead them to examine the track conditions on their own lines.

One of the practical measures for guarding against these causes (of derailment) is the use of guard rails placed in such a position as to assist in guiding the wheels around the curve and draw the flange away from bearing hard against the outer rail. The guard rail that performs this duty is the one placed adjacent to the inside rail. Its function is to engage the back of the inside wheel at the time the flange of the outside wheel is against the running rail. To perform this function it is absolutely necessary that this guard rail be rigidly fixed so that its position with reference to the outside running rail is always maintained. The great tendency of track men is to maintain a given width of throat (or flangeway) between the guard rail and its adjacent running rail, overlooking the fact that the real function of these inside guard rails is to protect the wheel running on the opposite rail. A slightly tight gage of track in such cases renders the guard rail useless. Where inside guard rails are used adjacent to both track rails, it is necessary to place them so that the distance between the throatway sides of the rail heads is never greater than the minimum standard allowance back to back of wheels, otherwise there would be strong tendency to derailment.

The elevated railway has the two inside guard rails throughout the length of the curve under consideration, evidently recognizing its full value when properly used. The position of these guard rails with reference to the running rails which they are supposed to protect is a proper subject for criticism, particularly through the crossing on which the derailment occurred. The following conditions were found to exist (at the Wabash Ave. and Van Buren St. crossing):

1. Track gage narrow near the north end frog of the crossing and the guard rail adjacent to inside rail not properly performing its service.

2. Midway between north end frog and center frogs, both gage and guard rails about right.

3. At middle frogs, gage wide and guard rails probably too wide apart for proper clearance back to back of wheels.

4. Midway between center frogs and south end frogs both gage and guard rails were practically right.

5. At south end frog the inside guard rail was too close to outside track rail to prevent a strong tendency of wheel flange to strike the frog point and derail.

6. The two most dangerous points in this crossing as installed are at the center frogs and at the south end frog. With the guard rails apparently too far apart to properly clear the distance back to back of wheels and with the unbalanced centrifugal force throwing additional weight on the outside rail the tendency would be for the inside wheel to mount over the guard rail ,thus allowing the outer wheel to catch the middle frog point and derail the truck.

In this connection, the inspection of the crossing now in place where derailment of an Oak Park car occurred at 5th Ave. and Van Buren St. (see cut) shows conditions that tend to derailment, particularly at the west end frog of the crossing.

*

Hudson River Bridges and Tunnels at New York City are again considerably in the foreground through the activities of interstate bridge and tunnel commissions of New York and New Jersey. Henry W. Hodge and J. Vipond Davies as consulting engineers, Mr. Hodge working on bridge schemes and Mr. Davies on tunnel schemes. An earlier commission a few years ago advanced a project for a bridge at 179th St. (Manhattan), but borings showed that rock could not be found at any practicable depth; in fact, several borings did not discover rock.

At the present time the bridge proposal under consideration is for a location near 57th St., with a main span of 2800 ft. Borings are now being made to determine the character of foundation soil available. On the Manhattan shore at the pierhead line rock has been found at but little over 150 ft. below water. On the New Jersey side it is expected to lie at greater depth, probably 200 ft. or more, but still within practicable depth. A complete project for a 2800-ft. suspension bridge with 612-ft. steel towers and capacity for eight lines of track has been elaborated. This bridge is quite closely similar to the eyebar-chain suspension design of Gustav Lindenthal for the Manhattan Bridge and the Quebec Bridge, the stiffening truss being formed immediately below the suspension chain. Ground level on the New York side would be reached at Ninth Ave., while on the other shore the bridge would extend to the top of the Bergen Hill ridge. No cost estimates of any kind have been advanced, but an earlier estimate of $35,000,000 for a 3000-ft. suspension bridge is referred to. As this did not include real estate or damages, the total cost is certain to be much larger.

A tunnel project has been worked out for a more southerly location, reaching lower ground on the New Jersey shore. The best line is recommended as extending from Canal and Varick Sts., New York, to Provost and 13th Sts., Jersey City, the latter point being between the Erie Ry. and D., L. & W. R.R. terminals. With 3% and 3.7% end gradients, a tunnel length of about one mile results. Two tunnels, each for a single roadway, are estimated to cost $11,000,000, including real estate, etc.

The wagon traffic between New York and New Jersey over the present ferries amounts to about six million per year, or about 20,000 per day. This includes the ferries from Liberty St. (to Communipaw) north to 130th St. (to Edgewater).

A series of public meetings has been held recently in cities of northern New Jersey under the auspices of the New Jersey commissioners to explain the projects to the people and get an indication of the public demand for a crossing and the preference as between bridge and tunnel, with due regard to the fact that for the cost of one bridge a large number of tunnels at different locations could be built.

John Fritz

John Fritz, probably the most widely known and signally honored of American engineers and well-nigh the last survivor of his generation, died on Feb. 13 at his home in Bethlehem, Penn., in his 91st year.

It usually happens when a man thus far outlives his contemporaries that he becomes almost forgotten by the men in active life. But Uncle John Fritz, as he was affectionately known by engineers far and wide, had so kept in friendly touch with his professional brethren that the news of his death brings a sense of personal loss to a wide circle.

Few engineers have gained a wider and more deserved fame than this pioneer Pennsylvania ironmaster and engineer. A rugged constitution, a clean, temperate and well ordered life, a cheerful disposition and a clear conscience prolonged his years of active life as well as his serene old age far beyond the usual lot of man. His many friends are thankful that he was so long spared to enjoy those expressions of sincere esteem and affection which mankind so often neglects to bestow upon the living.

John Fritz was born Aug. 21, 1822, in Londonderry Township, Chester County, Penn. He was the oldest of seven children, three boys and four girls. Of his parents he says in his autobiography,* they were of "exemplary character, my father being a man of high moral standards, who fully impressed upon my mind the importance of absolute integrity, energy and economy; my mother was a true Christian woman." His father was a native of Hesse Cassel, Germany, who came to this country in 1802, with his father's family. John Fritz's mother was a native of Pennsylvania, born of Scotch-Irish Presbyterian parents.

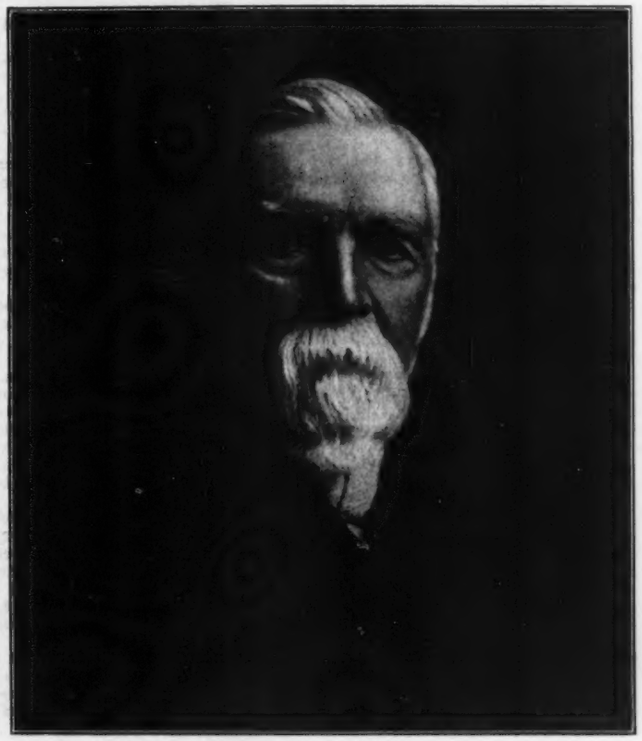
John Fritz's boyhood days were spent on his father's farm, where, like most farmer's boys, he began to be an active worker between six and seven years of age. His schooling was, as he himself says, "sandwiched" in at such intervals as he could be spared, and at such intervals as the country schools of 1830-1840 offered opportunity. In 1838, when 16 years of age, he went to Parkesburg, Chester County, Penn., as an apprentice to learn the trades of blacksmithing and country machine work, such as repairing threshing machines for farmers and making renewals required by the primitive cotton and woolen mills of that day, or for grist and saw mills, blast furnaces and forge plants. Some five years later this business became dull, and as his father's work as a millwright compelled him to somewhat neglect the farm, John Fritz returned "to the plow and to his first love, the farm." But, he says, "the little knowledge I had gained of mechanics made me eager for more, so I made up my mind to take up the iron business as a calling."

Business revived to some extent in 1843, and in 1845 he was enabled to return to an occupation in which he always took the greatest pleasure. This early experience in iron making is delightfully described in the short autobiography which follows, so we will here pass over it, and briefly sketch his subsequent career.

In 1854, John Fritz went to Johnstown, Penn., where he rebuilt the rail mill of the Cambria Iron Co. In 1857 he built there the first three-high rail mill ever constructed, carrying out the work in the face of strong opposition both from the workmen and some of the own-

*Published by John Wiley & Sons, New York City, 1912.

ers of the plant. In 1860, he was made General Superintendent of the then newly organized Bethlehem Iron Co. This position he held for 32 years, until he retired from active work for the company in 1892, at the age of 70 years. The iron mills of the company were built and started in operation under his direction in 1863, and the Bessemer steel works in 1873. In 1886 the Bethlehem works were the first to engage in the manufacture for the government of hydraulic-forged openhearth steel armor plate and forgings for heavy guns. A complete new plant was built under Mr. Fritz's directions for making, shaping and tempering the steel. The new works were the finest of their kind in the world, and included a 125-ton hammer, a 14,000-ton hydraulic forging press and a machine shop for finishing the heaviest gun forgings.



John Fritz

His retirement in 1892, however, did not mean retirement from the practice of engineering, for he retained all his mental activity until the last, and was long a consulting engineer and expert of the highest authority on iron and steel manufacture. In 1897 he was selected by the United States Armor Plate Board to make plans and estimates for a proposed government armor-plate works. In 1904 he was honorary expert on iron and steel at the Louisiana Purchase Exposition, St. Louis, Mo.

John Fritz was the recipient of so many honors that it would be difficult to mention them all. He was an honorary member and past-president of the American Society of Mechanical Engineers, an honorary member of the American Society of Civil Engineers, a past-president of the American Institute of Mining Engineers, an honorary member and past-vice-president of the Iron and Steel Institute of Great Britain and of the American Iron and Steel Institute. He held honorary degrees granted by Columbia University, University of Pennsylvania, Stevens Institute of Technology and Temple University. He was the recipient of the Bessemer Gold Mdal of the Iron and Steel Institute of Great Britain, of the John Fritz Gold Medal of the United Engineering Societies, and of the Elliott Cresson Gold Medal of the Franklin Institute.

Although himself denied the advantages of an education, he fully appreciated the value of technical training. He was a trustee of Lehigh University from its foundation in 1866 to the time of his death, with the exception of a few years, during which, at his own request, he was relieved from active participation in the affairs of the University; and he was ever liberal in his contributions for support of the institution. The Fritz Engineering Laboratory will long remain a monument not only of his generosity, but of his whole-hearted esteem for the work done by the University for many of his younger friends and assistants.

No account of the life of John Fritz would be complete without mention of the famous anniversary dinner given in his honor at Bethlehem, on Sept. 28, 1892, in commemoration of his 70th birthday. Few men either in public or private life have ever received a more enthusiastic and sincere compliment from friends and acquaintances from all parts of the country, from men distinguished in every branch of engineering and industry. A similar notable occasion was the John Fritz banquet, held in New York City, Oct. 31, 1902, to celebrate the foundation of the John Fritz Gold Medal of the United Engineering Societies.

A more graphic picture of John Fritz's life and character than we could possibly write is given in a brief autobiography, never before published, which we are able to present to our readers herewith. It was written by Uncle John, seven years ago, in response to a request from Dr. W. F. M. Goss, Dean of the College of Engineering, University of Illinois, and now President of the American Society of Mechanical Engineers. Dr. Goss had asked Mr. Fritz for some account of his life and work that might be a source of instruction and inspiration to the engineering student. We are indebted to Dean Goss's courtesy for the privilege of publishing Mr. Fritz's letter written in response to this request.

My dear sir—Yours of Feb. 16, making inquiry in regard to my application to business, is before me. This is rather a delicate question for me to answer, as I have at all times tried to avoid notoriety as much as possible, and I request you to give what I write as little publicity as possible, consistent with the purpose you want it for, which I suppose is for an example for students who will not give their studies proper attention. I will therefore give you a very brief outline of my rule of application to business, to which I attri-

bute my success—whatever it may have been.

I was apprenticed in the old-fashioned way, being bound out for a given number of years to learn blacksmithing and the country machine trade. In 1845 I left my home to try my fortune in the world, and went to Phoenixville in order to get work in the rolling mill, but was told that business was very dull, and that they had more men than they knew what to do with.

I there learned that a new mill was building at Norristown, and at once concluded to go there and see if I could get something to do. I went direct to the office and told the proprietors what I wanted, and was told that they had more men than they wanted; their mill was not completed, and if it were finished, times were so dull they would not start it.

I left the office, and in going back to the street, I walked through the mill and was looking at some of the machinery when one of the owners came into the mill and came up to me. I thought that he might order me out, but these thoughts were soon dispelled. He at once commenced to talk to me in a very pleasant manner.

After a pleasant talk, he asked me if I was used to hard work, to which I frankly answered, "Yes." Then he wanted to know where I was raised. I told him on a farm and what I had been doing. To all of his questions I gave him a prompt answer. He then said: "Young man, I like thy looks. Will thee remain until Monday?" I replied by saying that if there was any probability of my getting employment, I would be pleased to remain over Sunday. He then said that the manager was absent, but was expected to be at the works on Monday morning, and I should call about eight or nine o'clock.

I remained over, but it was both a long and an anxious period from Saturday evening until Monday morning in a strange place. At length the appointed time came around, and I was on hand promptly. In a short time Mr. Moore, accompanied by a large, fine-looking man, came near where I was standing and halted, and had a short conversation in an undertone. To me this was a most trying ordeal, as I supposed it was to determine my fate.

After the brief conversation, they walked up to where I was standing. Mr. Moore introduced the gentleman as John Griffin, the Manager. I confess that I had some dread of meeting him, as the word "Manager" at that day seemed to my simple mind to mean a supercilious kind of person who would hold one at a distance; but this was not the case. He was a fine-looking and affable gentleman. After some hesitation, I told him what I wanted. He asked what I had been doing and if I was afraid of hard work. I answered both questions in a manner that seemed satisfactory to him. He told me to come to work the next morning.

When I entered the mill the next day to go to work, I fully realized the fact that I was among entire strangers without friends or prestige, or compass to direct my course, with mind untrained for systematic work or study, and with but scant education. My thoughts naturally went back to the scenes of my boyhood days—to the old home where my kind parents and loving sisters and brothers remained. I now fully realized that I was enlisted in the army for the great battle of life, and made up my mind that I would faithfully do my duty in whatever position chance might place me, always keeping my eyes and ears open and my mouth shut. This is important. A man who is an habitual talker is an abominable nuisance about a plant, and no manager wants him.

In 1845 or 1846, then, I succeeded in getting a job—now called a situation—in the Norristown Iron Works as a country machinist, who at that day was not considered worth much. I started in at $1.25 per day, but my pay was soon raised to $1.50, that being the regular machinist rate of wages.

I was at the works with tools in hand when the bell rang. I idled no time away, and was ready and willing to do anything I was called on to do, and did it willingly, pleasantly, and with energy. The result was that when the mill was completed and put in operation, I was placed in charge of all the machinery in the plant, which to me was a great surprise.

Having previously made up my mind that the iron business would become a leading one, I was now placed in a position to get a very general knowledge of rolling-mill practice—a very important branch of it. But I soon made up my mind that to be a success, it was essential to learn all branches of it practically.

At that time puddling was the most important, the most difficult, and the most laborious of all branches of the business. But in face of all its difficulties, it was clear to my mind that I should learn it. As my time was occupied during the day, it had to be learned in off hours, which meant at night. After having my supper, I used to return to the mill and work at the puddling furnace until ten o'clock—at times later—every night, Saturday and Sunday nights excepted. This was no child's play, but I was on hand every night that the mill ran until I was well posted in the art.

About this time, there was another great surprise for me. I was called to the office without knowing what it was for, and I confess even at this late day, I well remember that as I had never been sent for before, I went to the office with some fear that they were in some way dissatisfied with me. When I entered, I found both partners in their private room and both of them seemed in a pleasant mood.

Now this is especially for your boys, and they should commit it to memory and ever have it in mind.

Mr. Moore, the senior partner, said that the man (calling him by name) who had charge of the mill in the night time, was not giving satisfaction, and they had dismissed him and wanted me to take his place. I was amazed for a moment. After gathering myself together again, I said to them: "I do not want the position, and if I did, there are four other men (naming them) that are older than I and have been with you longer than I have." Two of them were nephews of Mr. Moore, and the other two were friends of both Mr. Moore and Mr. Hoover, the proprietors of the works.

Mr. Moore, who was the spokesman and a Friend, said: "John, if I were going to look for thee any time after thee got thy supper till ten or eleven o'clock, I should come to the mill; if for either of the others, I should look over the town, and we insist upon thee accepting the position. To us, it is very important to have a person there at night that we have full confidence in."

Consequently I accepted, though reluctantly, as I was fearful that it might in a measure interfere with my opportunity of gaining practical knowledge of the manufacture of iron. Fortunately, I had gained a good knowledge of the art of puddling, which to learn properly made it necessary to be at the furnace from the time the heat was charged until the metal was finished, taken out and rolled, which required some two hours.

In the course of some three or four weeks, having got things in quite good shape, I found it the very place in which to become well posted in all the different branches, as it was necessary for me to look carefully over them all.

In learning to puddle, I acquired the skill necessary to work a furnace properly, which assisted me very much in becoming a heater. Learning to roll was not at all difficult, for being a blacksmith, handling the tongs came naturally, besides I was not confined to any given length of time. I could take the tongs and roll for five minutes, more or less, as the opportunity occurred. But getting up the templates for the rolls at that time was quite another matter. Having but little experience and no books on the subjects, at least none that we knew of, we had to think them over thoroughly and experiment with them until they would work all right.

Having now graduated in all the branches in the mill, in the manufacture of bar iron, pipe iron, boiler plate, tank iron, band iron, nails, car axles, shafting, heavy rounds and squares, and about all kinds and sizes of iron that were there being manufactured, I concluded that the rail business, although in a most deplorable condition at that time, would eventually become a leading branch of the iron business, and made up my mind that it would be important to know something about that.

At this time there was a rail mill going to be built at Safe Harbor, near Lancaster, Pennsylvania, and the owners wanted me to go there to erect the machinery in the mill. This was just what I wanted to do. At once I had a talk on the subject with Mr. Moore and Mr. Hoover, and they both advised against it, saying they did not want me to leave them, and that I would not get the salary that I was getting with them. I said that that was true and that I did not expect it, my object being to learn something of rail manufacture, as I believed there was a great future in it, and they finally consented to let me go.

When I left Norristown, I went directly to Safe Harbor and put the machinery in place, and remained there some two years, being finally driven away by fever and ague. I then returned to Norristown to my old place.

When Mr. Reeves learned that I had left Safe Harbor, he sent for me to come and see him, and he wanted me to go to Phoenixville and take charge of the machinery and shops there, which I declined to do, saying that one of my objects in going to Safe Harbor was the hope that I might get some knowledge of blast-furnace practice, and I had failed in consequence of being driven away by chills and fever.

Mr. Reeves said: "Well, I have just leased the old furnace

on the Schuylkill River near Philadelphia, and am going to remodel, repair and get her in blast. How would you like to go there and take charge of the repairs and improvements and get her in blast?"

I told him it was just what I should like to do if Moore and Hoover would let me off. He said that he could not pay me the wages he offered me to go to Phoenixville, but could only pay about one-half. I told him that would be all right, as it was not money I was after so much as information and experience, and if Messrs. Moore and Hoover would let me off, I would accept his offer.

On my return to Norristown, I had a very full talk with Mr. Moore and Mr. Hoover on the subject, and told them frankly the conversation I had with Mr. Reeves, and said that if they were willing, I would accept Mr. Reeves's offer. They and all my friends said that I must be crazy to leave the position I had and accept one that they considered much inferior at a lower salary.

I then had a private talk with Mr. Moore, saying to him that I had now had practical experience in all branches of the manufacture of iron except the work of the blast furnace, which is the first of all, and that I could not be a thorough practical ironmaster without having a practical knowledge of the blast furnace. He said that the view which I took was quite correct, and consented to let me go after some work that I had on hand was completed, after that was finished he said he would be satisfied to let me go, and to this arrangement Mr. Hoover subsequently agreed.

I now took hold of the project of remodeling and rebuilding the furnace and getting it in blast. This was accomplished with complete success, and I remained with Mr. Reeves about two years. I then returned to Messrs. Moore and Hoover to make some improvements in their mill.

Having obtained a very general knowledge of the iron business, both in the mechanical and practical working of the same, and also in the conversion of pig iron to wrought, and putting it in shape for the market, I in company with others put up a foundry and machine shop, with the view of remodeling and building blast-furnace and rolling-mill machinery.

Before the shops were completed, Mr. David Reeves, in company with a few others, leased the Cambria Works at Johnstown, Pennsylvania, and insisted on my taking the position of general superintendent; and he having strong claims on me, I accepted the position—whether wisely or unwisely I have never been able to determine.

The plant was new, yet it was not possible to make a commercial success with it without many changes and betterments, which involved the remodeling and rebuilding of the whole plant. This I did, and at the expiration of six years of the most strenuous labor, I left the works with their acknowledged supremacy as the best rolling-mill plant in the world.

On the morning of July 5, 1860, I bade Cambria Iron Works people good-bye and arrived in Bethlehem the same evening; and on the morning of the sixth, I entered the employ of the Bethlehem Iron Co. and built the iron and steel plant, and later on erected the hydraulic forging plant, the machine shop, and the armor-plate plant and finishing shop.

I have written you many times more than I intended, but there is nothing in the sketch that will not be a benefit to the students if it can in some way be impressed on their minds.

Now a word about application to business. It has been my rule through life to be at the works every morning, Sundays excepted, winter and summer, at half past six, breakfast being over before I leave the house.

This gives me time, if anything has gone wrong in the night, to make arrangements for the repair men to go directly to whatever place they are needed, and to see that all the men are in their places. It is always better to say "Come boys" than "Go boys," and an hour in the morning is worth more than two in the afternoon.

At half past eleven, some of the principal foremen go to their dinner, and about half past twelve they return. Then I go to my dinner and return about two o'clock. I get my supper about half past six and return to the works at half past seven and remain until half past nine; then I go home and go to bed at ten o'clock sharp, unless something is going wrong at the works, and then I know no hours until it is righted.

One Monday morning about one o'clock, we had not finished what were called "Sunday repairs," and when we came to put them in place, the work would not go together, in consequence of what was called a "machinist fit." In repairs, the rule was "loose fits" so that everything could be put together quickly, but in this case the rule had not been strictly adhered to, and a part of the work had to be sent back to the shop to be loosened so that it would go in place.

I was waiting for the job to come back and was not in an amiable mood. The mill men were there waiting to get started. I noticed an Irishman standing leaning on his shovel, looking at me. After a little while he walked over to where I was standing and said to me: "Mr. Fritz, I was standing looking and thinking and wondering how long you have been in an iron works." I said to him: "Some thirty-odd years." He said, "I have been with you nineteen years, and you have been making time and half time ever since I have been with you."

I write this to show that men do not often hurt themselves by hard work and long hours if they take proper care of themselves.

In regard to vacations, I never had but one in my life, and that was after a severe attack of typhoid fever. I was then away for some ten days. I once had a very bad case of pneumonia, and having much to do at that time, I had a room fixed up away from the works and some of my best draftsmen in it with me. This was done by the dector's advice to keep me away from the dust of the works.

Outside of fever and ague, typhoid fever, pneumonia, and an attack of erysipelas, the time I was away from the works on account of sickness would not average over one day in a year. This seems remarkable, as I was exposed to all kinds of temperatures—going from the hot furnaces out into the cold in winter, when the thermometer was down to ten. No matter how badly it stormed, I was at the works attending to my duties, and rarely took a cold.

My first work in the iron line was in 1838 at a charcoal furnace which made about 16 tons per week; the total production that year in the United States was 263,000 tons. This year (1905), at the rate it is now going, it is supposed that the production will exceed 20,000,000 tons.

I have not only been contemporary with the marvelous improvements that have taken place in the iron and steel industry, but have had much to do with their introduction and perfection.

In regard to the fifteen years you refer to, when I was building the Bethlehem gun-forging and armor-plate plant, one thing I did was to go abroad to see what they were doing on the other side of the water. I saw most of the large iron and steel and forging plants in England, Germany, Belgium and France, and was absent from home only about six weeks; and I think it was about the hardest work I ever did, except the building, organizing and getting the works started and the steel to stand the high physical test required by the government for the gun forgings and armor-plate.

It was my rule to make my own foremen, selecting them out of the men employed in the works, but when we came to select men to do work they had never seen, it was something of a task; but it was done and not one of the men selected to take charge had ever seen a plant for doing the kind of work he was called on to do.

The best and hardest and most difficult work of my life was done when I was between 65 and 73 years of age, yet many well-minded people are under the impression that men over 45 are quite useless. They seem to forget the fact that experience counts for much. An experienced man does his work better, faster and easier for himself and those around him than a novice, although a much younger man. A man with experience has confidence in himself, knows what he is doing, and does not hesitate. He goes ahead with the assurance that he is right.

My life has been an active one in the most laborious, exacting and important branch of manufacture in the domain of human activities, requiring courage, endurance, and a most varied talent. In August next (1906), I shall be 83 years old, and I am now hearty and active, both mentally and physically, and do not think that I am yet a proper subject for chloroform.

"John Fritz is a living proof of the results of individual and industrial liberty in a country endowed with boundless resources. . . . He is more to us than a man whom we love and respect, more than a friend to whom we wish many years of health and happiness: he is an example of the free spirit of American institutions, a beacon light warning the present and coming generations against permitting any invasion of the principle of the liberty of the citizen, which alone has made our beloved country great and free."—A tribute to John Fritz by the late Abram S. Hewitt, Oct. 31, 1902.

The Annual Meeting of the Connecticut Society of Civil Engineers

The 29th annual meeting of the Connecticut Society of Civil Engineers was held in New Haven, Conn., Feb. 11-12. The business session occupied the morning of Feb. 11, and the afternoon of that day and the morning of the next were devoted to the reading and discussing of papers. In addition to the day sessions, a banquet was held on the night of Feb. 11.

While the papers presented to the association were interesting, they were not of a controversial nature and did not bring forth much discussion. Inasmuch as most of them were upon subjects which have been fully treated in ENGINEERING NEWS, only brief reference to them will be given below.

The most interesting part of the meeting was the discussion on certain recommendations of the president, A. W. Sperry of New Haven. The president, in brief, recommended the appointment of a number of standing committees whose duty it would be to take up certain lines of endeavor, closely associated with the engineering profession, but which hitherto, in Connecticut at least, have not been considered the duty of an engineering association. The principal one of these recommendations was crystallized in a motion providing for a committee to be appointed by the Board of Direction to consider all bills before the Connecticut Legislature and after conference with the Board of Direction to take whatever action might seem best to benefit the engineering profession.

This motion immediately provoked considerable opposition. It seems that at present the State of Connecticut is in considerable political turmoil in regard to the administration of its highway commission. A Democratic governor, now holding office for his second term, has been unable to secure the confirmation by the Senate (Democratic now though Republican through his first term) of his own appointee to the office of highway commissioner, which office is still filled by the incumbent who has held office for some fifteen years. It happens that the contest for the office has degenerated into a political squabble in which the technical fitness of the various candidates has not been considered very much. For this reason a number of the more conservative members of the Society thought that it would be undignified for the Society to enter into the controversy in any way. Although the motion as put did not specifically refer to the highway commission matter, it was inferred by many members on the floor that this would be the construction put upon the motion by the citizens of the state who considered the matter at all.

The maker of the motion, however, referred to the confusion existing in the legislature regarding the organization of the highway department as well as all other departments in which engineering is concerned. There are now at least three bills before the Connecticut Legislature in which the engineering activities of the state are directly concerned. One of these provides for a state engineer's department somewhat similar to that in California, and another (toward which the activities of the commitee would be especially directed) organizes a highway commission to be headed by three members, "one to be a civil engineer, one an expert road builder, and one a practical road builder." Against such absurdities as this the committee would necessarily take action.

After some discussion the motion was passed with the instruction implied, if not specified, that the committee should act as a committee and not as representing the Connecticut Society of Civil Engineers. This was a concession to those who for some reason seemed to be afraid that the smut of politics would dirty the hands of the Society if the Society did not watch out.

Another motion provided that a committee should be appointed to investigate the subject of codes of engineering ethics and tables of engineering fees, and should make a digest of all such codes and tabulations which have been adopted by various engineering societies, such digest to appear in the next annual proceedings of the Society. This motion was more specifically directed toward the question of fees than that of ethics. It was felt that there it too much competitive bidding for engineering business and that it would be much to the advantage of every engineer if he could refer to some fixed table of proper charges in making his bid for work or in consultation with a possible client.

Other committees were appointed to take up the question of uniform building laws, water power, deed registration, etc.

PAPERS

The leading address the first day was by F. Herbert Snow, Chief Engineer, Department of Health, Pennsylvania, and was entitled a "10,000 Square Mile Sanitary Survey." Mr. Snow's address, which was most profusely illustrated by lantern slides, took up in minute detail sanitary study of the Allegheny River Valley. This included a study of the iron, coal, oil, gas industries of the region, with the effect of such industries upon the adjoining water courses and consequently upon the Allegheny River. The latter part of the address was devoted to the problem of the water supply of the metropolitan district of Pittsburgh, which is served now practically entirely from the Allegheny River.

Another address was delivered the same afternoon by Dr. W. R. Whitney, who is at the head of the research laboratory at the General Electric Co. at Schnectady. Dr. Whitney took the members on an imaginary trip through the various rooms of the large research laboratory of the company at Schenectady, and described as well as might be in the limited time afforded him the different problems which the chemists in that laboratory have before them.

On Feb. 12 the first paper was by Clarence Blakeslee, of the firm of C. W. Blakeslee & Sons, contractors, who held one of the large contracts on the new Catskill aqueduct. This illustrated lecture by Mr. Blakeslee described the new Catskill aqueduct of New York in general, and more specifically that portion of the aqueduct which Mr. Blakeslee's firm had under contract and which they recently completed.

The second address was by Charles R. Harte, of the New York, New Haven & Hartford Railroad Co., on a "Modern Electric Power Net Work, the Waterbury-New Britain System." This power net work comprises a combination of hydro-electric and steam electric plants spreading between the Housatonic River and Hartford, New Britain, Waterbury and outlying districts. It was one of the pioneer high-tension lines, being the first in the eastern part of this country to distribute current over

an 11,000-volt line. Mr. Harte's paper took up the hydro-electric plant and the line construction in particular.

The third paper of the day was by Wm. S. Murray, electrical engineer, New York, New Haven & Hartford Railroad, on the electrification of that railroad. His preliminary talk was mainly a defense of the use of the single-phase system by the New Haven road in contradistinction to the direct current which has been used on similar work by other railways. He said that undoubtedly the road had to undertake a great lot of pioneer work, but that the future seemed now to justify it. It would have been easier to have built a direct-current line, but such a line would not have admitted of the progress which it is hoped the present installation will allow.

Officers

The following officers were elected for the ensuing year: President, Sheldon E. Minor (Greenwich); 1st Vice-Pres., George K. Crandall (New London); 2nd Vice-Pres., C. C. Elwell (New Haven). The secretary is J. Frederick Jackson of New Haven.

Block Signaling and Train Control Report

SYNOPSIS—A Board was appointed by the Interstate Commerce Commission in 1907 at the direction of Congress, to investigate the use and necessity of railway block signals. In 1908, the work was ordered continued by Congress and broadened to include the study of appliances and systems intended to promote the safety of railway operation. Annual progress reports have been made each year and recently the final report has been issued. A considerable portion is reprinted below, showing the general development and present status of block signals, automatic train stops, rails, ties, high-power headlights, car couplers, and automatic train-pipe connectors.*

STATISTICS

Since the organization of the board in July, 1907, 1146 devices and systems intended to promote the safety of railroad operation have been brought to the board's attention, and in 1047 cases complete plans have been furnished. All of these 1047 cases have been disposed of, opinions regarding the practicability and merit of the devices or systems having been transmitted to the proprietor in each case.

THE BLOCK SYSTEM

The block-signal system as used on the railways of the United States was one of the two principal subjects assigned to this board for investigation when it was appointed.

The mileage of road block signaled at the beginning of this year was 30% greater than on Jan. 1, 1908, as shown by the following comparison:

	1912 Miles	1908 Miles
Manual	56,074.8	47,875.7
Automatic	20,334.9	10,803.0
Total	76,409.7	58,678.7

In automatic signaling it will be seen the increase in these four years was almost 100%. The automatic system, superior in many respects to the manual, has in many cases been installed in place of the manual system.

Excepting this statement of mileage, there is nothing of importance to report under this head as having occurred since the last report. The five years' observations of the board may be summarized.

The desirability of using the block system as the only reasonably safe method of regulating the movements of railway trains, which had already been set forth by the Commission in several of its annual reports, was confirmed. The soundness of the principle that the block system is the one and only adequate method now known of spacing trains not only has the constantly renewed indorsement of the majority of prominent railroads, as evidenced by their action in extending its use, but there is a special and significant indorsement in its use on an increasing number of lines which are used only by freight trains. In using the space-interval system on such lines the railroads go further than the board or the Commission has yet proposed to go; and their action tends to disprove the notion that superficial or short-sighted motives, such as advertising, or a narrow consideration of nothing but prospective damage bills for passengers killed or injured, constitute the main reason for introducing the block system.

*See "Engineering News," Jan. 14, 1909.

The simple manual block system under regulations was used on the Northern Pacific—the "A B C system"—increasing its safety without the addition of costly electrical apparatus, and simplifying and cheapening the operation by abolishing the timetable and its complicated rules. But the system was abandoned by the Northern Pacific. Besides the reason for abandonment given by the company, it seems proper to mention what appears to have been a powerful collateral reason, namely, the fact that in returning to the use of the timetable (with or without some manual block signaling carried on under the old regulations) the number of operators (and the amount of salaries paid) could be considerably reduced. A change has been made in the A B C system which has improved it. This is in the provision for moving trains in case of failure of the telegraph wire. Instead of an emergency timetable, to be put into use by the station operators in such a case, the simple train staff, with no electric locking from station to station, is provided. This is simpler, more easily understood, and safer than a timetable, and, we are informed, worked satisfactorily.

AUTOMATIC TRAIN STOPS

The automatic train stop, the investigation of which was one of the two chief purposes aimed at in the establishment of this board, continues to be a live subject. New data concerning it are being constantly evolved, and serious attention is being given it by competent engineers, so that both the science and the art are being developed along more practical lines than formerly. It is greatly to be regretted that the chief stimulus to these efforts lies in the recurring collisions due to causes that these devices are intended to prevent. The serious collision in the Hoosac Tunnel on the Boston & Maine R.R., near North Adams, Mass., on Feb. 20, 1912, resulting in the loss of four lives and thousands of dollars' worth of property, draws particular attention to the subject, for not only was that collision ascribed to the failure of the engineman to observe the fixed visual signals, but the locality in which it occurred is one where the use of automatic stops is peculiarly appropriate.

Inductive systems—that is, those in which electrical apparatus on the roadway acts upon electrical apparatus on the train by means of electrostatic or electromagnetic induction, and without any physical contact—continue to offer promise of success. An experimenthl installation of one such system is being tried in New York City.

In dealing with the mechanical-trip type of train stop the board recognizes as the only adequate standard for such devices that they be so designed as to detect their own failure; that is to say, to be in this respect as safe as electrical apparatus which is arranged on the so called "closed-circuit" principle. It insists that any mechanical trip, to be entirely satisfactory, should be so designed that the breakage or removal of the movable roadside member shall cause an application of the brakes. In a typical apparatus of this kind this object is accomplished by having a rigid roadside member so securely fastened to the track as to be as little susceptible to breakage or removal as a rail of the track itself. This rigid member acts upon the engine member of every train at every point of indication and causes an air-brake valve to be opened. This is the normal operation at the entrance of a train to each block section if the fixed visual signal is at "Stop" or if the block section is obstructed. If, however, the fixed signal is at "Proceed," or the route clear, the movable roadside member comes into operation to engage a member on the engine in such a manner as to prevent the escape of air from the brake pipe due to the previous opening of the valve by the fixed roadside member, or it in some

other way forestalls or nullifies its action. Not only does such an arrangement place the mechanical trip within the class of "closed-circuit" devices, but it assures that each apparatus will be operated every time a train passes a signal or a point of indication, thus affording a complete check of its operative condition. In the mechanical-trip systems heretofore tested and those now in use, the engine device and the roadway device never engage except for the purpose of making an emergency stop or when periodically tested, being in this respect in the same category as life preservers and fire extinguishers.

A number of devices have been submitted to the board in which the design of electrical circuits and of the apparatus is apparently of equal merit with that in some devices of the same class which have been tested. The board has not deemed it desirable, however, to conduct tests of two systems embodying the same principle until it has completed at least one test of each of the following types of apparatus: (a) ground mechanical trip; (b) intermittent contact rail; (c) devices having insulated short-track sections and insulated wheels or axles; and (d) inductive electrical devices. The board has considered it important to have available the information and data obtained from the first test as a guide in future tests of similar devices.

The board greatly regrets that largely through the inability of proprietors of devices to provide proper installations it is not able to present with its final report any data covering tests and devices using insulated short sections of rail and insulated wheels and axles, or of inductive devices.

TRACK STRUCTURE

RAILS—In the use of steel rails prior to 1900, there were comparatively few rail fractures. During the past 10 years the breakage of rails has increased rapidly until now it is of very frequent occurrence. On some roads the number of broken rails found in a single day during the past winter was a matter of grave concern to the officers. It is probably owing to the use of the automatic block system and its track circuit, which in most cases detects broken rails, that more accidents of a serious nature have not resulted from these breakages.

It is of the greatest importance to discover the cause of these rail breakages. The Bureau of Standards in its investigations conducted for the Safety Appliance Division of the Interstate Commerce Commission has performed an excellent service, and this work, if continued, will no doubt contribute very materially to the solution of the problem. Of the number of things pointed out in the report of the Bureau of Standards two are conspicuous: (1) That by the present method of inspection faulty rails are passed for shipment from the mills, and (2) that rails are overloaded.

Since 1900, an effort has been made by the mills to hasten the metallurgical process, but the soundness of the metal has been decreased. One obvious method of improving the quality of rails would appear to be to take all the time needed to insure sound rails. Since 1900 cars and engines have greatly increased in weight. Simultaneously, high speeds have become more and more common. It requires only the briefest consideration to realize that the magnitude of rail shocks is directly proportional to the weight and to the square of the speed. Thus, if both the weight and the speed have been doubled, the intensity of the shock has been increased eight times.

It is true that the rail itself has also been increased in weight, rails weighing 100 lb. per yd. being now frequently used where formerly rails weighing from 60 to 80 lb. per yd. were used. As a standard 100-lb. rail has a strength of only about two and one-half times that of a 60-lb. rail and one and one-half times that of an 80-lb. rail, it is obvious that with the greater weights and speeds the rail load has increased quite out of proportion to the increase of rail strength. The importance of the rail problem is so great as to warrant giving to it most careful and systematic investigation.

TIES AND ROADBED—The board has devoted considerable time to the investigation of various designs of ties intended as substitutes for wood ties. The most that can be said for the many designs that have been submitted is that in general they indicate only in moderate degree an appreciation of the real problem to be solved.

The principal materials, other than wood, which have been used or suggested for railroad ties are steel, concrete, and combinations of these two materials. In this country the use of steel is slight as compared with foreign countries, but on a few roads, the Bessemer & Lake Erie in particular, the I-beam form of steel tie has been given a thorough trial. From the standpoint of strength, durability and adaptability to the use of proper track fastenings this form of steel tie can be said to be adequate. It furnishes a good support for vertical loads, and proper resistance for forces in compression, tension and bending. With stone ballast it holds the track in adjustment more satisfactorily than with light ballast. Projecting flanges have been used to secure greater resistance against displacement, and no reason is apparent why such flanges should not prove adequate.

Another prominent form of steel tie is the trough-shaped section, some having the opening of the trough downward and others upward. The dome or saucer-shaped section has also been used to some extent, particularly in Mexico. While moderate success has attended the use of the trough-shaped section with the opening upward, those forms with the opening downward have not met with such success that their use has been continued. This is apparently due to the working of the ties in the ballast, although in some kinds of ballast they have given satisfactory service.

Concrete ties are found in only a few experimental installations. These consist either of concrete, plain or reinforced, made in the same shape as wooden ties, or of solid blocks of concrete under each rail, opposite blocks being connected by metal tie bars which also take part in forming the track fastenings. Two installations of concrete ties were examined by the board, one on the Erie R.R., the other on an electric line near Buffalo. Those on the Erie, after several years' service on a branch line, were put into the main track, near Salamanca, but after a few months' trial they were removed and it is understood their use has been discontinued.

The examination of the concrete ties in use near Buffalo and Salamanca and of the steel ties on the Bessemer & Lake Erie indicates that when the track is ballasted with stone and is properly drained, the fear of a too rigid roadbed from the use of materials less elastic than wood is in large measure unfounded.

The use of concrete ties reinforced with steel must remain a question for the future, as no examples of this type are in use.

The fundamental defect in design, which is the most apparent, is failure to realize and appreciate the overturning moment due to the wheel flange pressure against the head of the rail. It is not sufficient that a tie should support the vertical loads and resist direct horizontal thrust and the tendency of the track to move laterally and longitudinally, but this overturning moment must be resisted. This requires that the tie must be a beam to resist bending so that the overturning stresses may be properly transmitted and resisted.

In order that the tie may properly support the stresses transmitted to it by the rail, a suitable fastening of the rails to the ties is most essential. The driven spike commonly used with wooden ties is, of course, impracticable for steel, concrete, or composite ties. The type of track fastening will necessarily vary not only with the material of the tie, but also with its form. A common defect found in many designs is the complication of the rail fastenings. Where bolts are used both the head and the nut should be accessible and the bolts should be capable of renewal without disturbing the ballast to any extent. In many designs of track structure an outside rail chair or brace is used to prevent the overturning of the rails. It is generally formed to fit the contour of the rail, and intended to act as a compression member only. The strength of the rail section itself when subjected to outward bending is more than sufficient to prevent overturning if the bottom flange of the rail is securely held down to the tie. Thus held, there would be no need to resort to outside braces.

A large number of designs presented indicate that the inventors are quite unfamiliar with the ballast and weather conditions encountered on many railroads, particularly in winter, as they make no provision for shimming. Under the action of frost the roadbed heaves, often to a considerable extent and frequently in a very uneven manner. The ties are frozen in the ground, and such undulations of surface are caused by the uneven freezing or heaving that the rails must be shimmed or blocked up above the surface of many of the ties in order to produce a rail surface sufficiently even to carry traffic safely. Under the conditions existing on a large proportion of the railroads in this country the means of adjustment of rail to tie must be such as to admit of this blocking up or shimming, though as the roadbed becomes older and better compacted and as stone ballast is introduced to a sufficient depth the necessity for so doing diminishes.

To provide adequately for shimming or for widening the gage appears to have been a difficult problem for inventors, as it involves the use of adjustable fastenings, with consequent chance for lost motion and change of adjustment. In turnouts and in main-track curves of less than a certain radius it is desirable to widen the gage of the track, and

many designs of ties submitted make no provision for so doing.

Another factor having to do with both form and material is the question of insulation of the rails on the one side of the track from those on the other, where electric track circuits are used for signaling. The electric track circuit is coming more and more into use, and no design of tie can be deemed suitable for general use which does not adequately provide for insulation of the rails from the ties.

HEADLIGHTS

From a study of the devices submitted, the board believes that it is not practicable properly to control the direction of a headlight beam through the swiveling of the trucks or by any relation of the train or engine to the track upon which it is running, but that simple mechanical means may readily be designed to swing the headlight so that the engineman may, within limits, have complete control over the direction of the beam.

As a general conclusion regarding locomotive headlights, the board believes that a headlight should be considered either as simply a marker to indicate to stationmen and other persons concerned the approach of a train or, if it is to be used as more than a marker and is intended to be used for the detection of obstructions on the track at a sufficient distance to enable a train to be brought to a stop after they are sighted, the headlight should be a high-power light having both the direction and intensity of the beam controllable by the engineman. The control of the intensity of the beam by the engineman directly from the cab is regarded as a necessity, as when meeting or passing other trains and for preventing inmproper reading of fixed or classification signals. Perhaps the most common and the most weighty objection to the use of high-power headlights is that an engineman running in one direction is dazzled by the light of an engine coming toward him. To meet this objection it is deemed important that every high-power headlight should be so arranged that the engineman can occult it at will.

CAR COUPLERS

Since the passage of the sundry civil act of May 27, 1908, which directed the Commission to examine and report upon all systems or appliances intended to promote the safety of railway operation, the board has examined plans and specifications, as well as models, of numerous automatic car couplers. By reason of the requirements of uniformity and interchangeability to which such devices must conform, the inventors of car couplers are limited to a vertical-plane type of coupler which follows the contour lines prescribed by the Master Car Builders' Association, and their efforts must be confined to effecting improvements in design of the working parts of couplers of the M. C. B. type. The Federal safety-appliance law, which requires the use of couplers that will couple automatically by impact and which can be both coupled and uncoupled without the necessity of men going between the ends of the cars, together with the great increase in size and weight of trains within recent years, have rendered many of the earlier designs of the M. C. B. type of coupler unserviceable. To meet the new conditions, there has of necessity been a notable improvement in the mechanical design and construction of the working parts of couplers, while the type and contour lines prescribed by the Master Car Builders' Association have remained unchanged.

The knuckle-opening device is now in general use and is recognized as a necessary feature of the standard M. C. B. coupler. All M. C. B. couplers now manufactured embody some form of mechanism for automatically opening the knuckle. The use of a centering device is not so general, but the utility of some form of centering device is well recognized, and such devices are coming into use.

Most of the coupler designs that have been offered to the board for examination were considered impracticable, or inferior to couplers already in use. As an aid to inexperienced inventors, the board formulated the following desirable characteristics for automatic car couplers. They should:

(1) Conform to M. C. B. standard drawings and contour lines.

(2) Have a lock-set within the head of the coupler.

(3) Be so designed that they will not part when the knuckle pin is removed or broken.

(4) Be so designed that movement of the uncoupling means to unlock the coupler will open the knuckle.

(5) Be so designed that they will couple with each other with either or both knuckles open.

(6) Be so designed that the lock lift will not be more than 6 in.

(7) Have the fewest possible number of parts; and their operation must in no way depend upon the use of springs.

(8) Have the tail of the knuckle and the lock bearing so located that the axis of the drawbar will pass centrally through the engaging surfaces of the knuckle tail and the lock block, which must be of sufficient area to avoid excessive wear.

(9)Have the locking pin so designed that it will assume locking position freely by gravity, without being compelled to overcome friction or resistance from the unlocking means.

It is believed that the Master Car Builders' Association has the coupler problem fairly well in hand, and that couplers are now being furnished which meet the demands of safety as fully as can be expected owing to the restrictions of manufacture and in view of the exceptionally hard service to which such appliances are subjected.

AUTOMATIC CONNECTORS

The use of a practical device for automatically connecting the air-brake, steam-heat, and signal-pipe lines through a train is desirable, not alone from the standpoint of safety, but also because of economy and the saving of time in train operation.

The side-port and butt-face types of connectors cannot be used together, nor can the pin-and-funnel and wing types of gathering devices be used together. It is apparent, therefore, that until some one type has been decided upon by adequate authority and definitely adopted as standard, little progress in equipment for actual service can be hoped for. It is also true that because of the manifest impossibility of equipping all cars in service at the same time, any hose connector to be serviceable must be so constructed that it can be coupled to the couplings now in common use. The absence of such a provision in a connector is sufficient to prevent its adoption for general use. Another important question is the stopping of leaks and making light repairs. From an operating standpoint it is clearly impracticable to have an engine at hand for the purpose of separating cars whenever it becomes necessary to remove defective gaskets and insert new ones. Some means must be provided for doing such work while the connector heads are coupled together.

The connector designer must provide for additional requirements that are more severe than any which the car-coupler designer has to meet. Whatever form of gathering and registering device may be used with a connector, it is apparent that it must be capable of considerable distortion without destroying the ability of the connectors to register and lock in position when their faces are brought together. Not only for convenience and for obvious mechanical reasons, but also to make it possible to couple hand hose with the automatic connectors during the transition period, connectors should be located directly below the car coupler and in a vertical plane containing the center line of the coupler. To meet the requirements of the Master Car Builders' Association the center line of the conector head must not extend downward farther than 17½ in. below the horizontal center line of the drawbar. The central axis of the connector head must also be the center line of the air-brake port.

Some of the connectors which had been presented for examination possess theoretically good features which would seem to render them entirely practicable for general use. The usefulness of these theoretically good features, however, can only be determined by extensive tests of the connectors in which they are embodied, under the most severe working conditions which such devices are likely to meet in actual service. The board, therefore, arranged with the officers of the Great Northern Ry., for the equipment (with the Robinson connector) of 50 high-capacity cars. These cars are used in ore service on the Marcus division, on track having heavy grades and excessive curvature. The cars are heavily loaded in service and high brake-pipe pressure is used, so that the conditions are such as should afford a thorough test of the practicability of the connector for use in general railway service.

Owing to manufacturing difficulties encountered by the proprietors of the device the equipment was delayed far beyond the time of its expected completion, and the board is therefore unable in this report to present any details concerning the performance of this connector.

INSPECTIONS

In previous reports references have been made to inspections carried on by the board covering signaling practices, methods of operation, and conditions of roadway. These inspections have been continued. They have been made for the double purpose of (1) carrying on the investigation relating to block-signal systems and other devices intended to promote safety in railway travel, and (2) to set forth in a summary for the benefit of the officers of railroads any bad practices or unsafe conditions observed.

In signaling, many instances have been found where signals were out of order; portions of the track without track-circuit protection; signals improperly located amid surroundings which tend to create confusion in their observance; lack of sufficient tools, lanterns, and flags; giving of hand signals from interlocking towers; drawbridges without any kind of protection; and many cases where interlocking towers were found in filthy condition. In methods of operation, practices such as the handling of train orders in cramped quarters and amid confusing surroundings; allowing some trains to pass block signals in the stop position without stopping; practices connected with the flagging of trains, particularly trains which are not fully manned, thus requiring the flagman to perform services liable unduly to take his attention away from flagging, are some of the many defects or deficiences to which our attention has been called.

GENERAL CONDITIONS AFFECTING SAFETY

In discussing this subject it may be assumed at the outset that railroad officers and employees are as anxious to do everything in their power to promote safety as the public is to have safeguards provided, and that railroad officers and employees are not immune to the horrors of a terrible wreck. The railroad officer responsible for results does his utmost to meet the demands made on him. His first responsibility, as he sees it, is to provide earnings. It is but natural, therefore, that he has given chief attention to the conditions directly affecting the financial end of the business, and less attention to the conditions affecting safety. Safety he very much desires, but earnings he must have.

The public should squarely face its share in the responsibility for safety. The comfort and luxury which it now demands are costly. The high-speed train which was a special event 20 years ago is now a feature of the regular schedules. The American people cannot wait; they crowd the steps to get on a train and the aisles to get off. Comforts and luxuries are demanded without increase of expense to the traveler; not only that, but with a very general demand for a decrease in prices. Every added demand upon existing facilities and methods introduces sources of danger. As the demand does not diminish, it seems necessary that methods and facilities must improve if the standard of safety is to be maintained.

As regards methods, it may be said that on the large majority of American railroads excellence of administration is nullified by faulty organization, magnification of individual function to the detriment of team work, and by an almost entire absence of a definite system of broad training of subordinates for higher duties. These, and the shifting of responsibility from one officer or department to another, prevent the attainment of that high order of discipline and morale which must be had if carelessness is to be overcome and skill and painstaking loyalty govern the acts of the men on whom the public must depend for safety in travel. As has been observed in former reports, this condition is largely due to causes which have their roots in the conditions of society in America.

While the deficiencies noted above may explain, they can hardly excuse failure to take greater advantage of the facilities for promoting safety which already exist or are ready for final development by the railroads. The railways have been slow in installing the block system, long since demonstrated to be the prime requisite for safety against collision. The railroads have failed to investigate as fully as they should the availability of devices to supplement the block system as now used, and which if adopted would add directly to the safety secured by existing means. This question of neglect of definite measures affects the public also. The failure of the Government to require the installation of the block system is a definite feature of recent congressional history, there being more and stronger reasons to require this improvement than exist for the use of some other safety devices now required by law. Intelligent coöperation by the States and the Federal Government in establishing more uniform requirements for the operation of railroads would result in marked advancement and help to do away with the uncertainty felt by railroads as to their future.

CONCLUSIONS

In concluding its final report, the board summarizes the recommendations made in its several reports as follows:

(1) The compulsory adoption by all interstate railroads of the block system. That system has long since passed out of the experimental stage. As regards the manual block system this recommendation implies the careful selection and thorough training of the block signalmen and the constant, regular and thorough inspection of signal operation and methods. The automatic block system must be carefully and thoroughly installed and constantly inspected.

(2) The development of the automatic train stop has proceeded far enough to warrant the expectation that by its use greater safety can be secured in the operation of trains. Railroads should be given to understand that the automatic train stop must be developed by them as rapidly as possible.

(3) Railroad tracks should be properly inclosed and the laws against trespassing thereon enforced. Grade separation should be encouraged and in certain localities required.

(4) The payment of pensions by the railroad companies to their superannuated employees would do much toward creating loyalty and stability in railroad organizations.

(5) There should be more complete coöperation of the State and Federal Governments on the one hand and railroad companies on the other in order to bring about more stable conditions throughout the entire country. Piecemeal legislation should be brought together and harmonized into general enactments, comprehensive in character and based on the best standards of practice. The board recommends that the enforcement of this general legislation be intrusted to a body having powers similar in character to those now provided for and administered by the Railway Department of the British Board of Trade.

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The Commission Plan of Government was adopted by the city of Denver, Colo., on Feb. 14, by a large popular majority. The vote was on a series of amendments to the existing charter.

Panama Canal Excavation during January, totaled 2,612,020 cu.yd., a daily average of 100,642 cu.yd. for each of the 26 working days. The monthly rainfall was 2.82 in. The amount of concrete laid in January was 91,362 cu.yd. and 222,002 cu.yd. of fill were placed in dams.

The Water-Works Standpipe of the Cairo Water Co., Cairo, Ill., fell on Feb. 11, 1913. The Company has wired us the following infomation, at our request:

The standpipe was built in 1885. It was originally 150 ft. high, was later increased to 175 ft., and was 16 ft. in diameter. The standpipe did not collapse, but fell over and broke after falling. Our opinion is that on account of long continued high water the earth became so softened that the foundation was weakened.

According to "The Manual of American Water-Works," the Cairo works were built in 1885 and put in operation on Jan. 1, 1886, by Peter Herdic, under the name of the Cairo Water Co. The earlier issues of the "Manual" gave the surname of the constructing engineer as Ditmar, of Williamsport, Penn., and later issues stated that James H. Harlow & Co., Pittsburgh, Penn., were designing engineers. The contractors for the standpipe were Maittang & Son, Peoria, Ill. The standpipe must have been raised before 1897, since the "Manual" for that year gave its height as 175 ft. The water-supply of Cairo was pumped from the Ohio River.

We hope to give particulars of the failure in a later issue.

A Series of Lectures on Radioactivity is being arranged for March and April under the auspices of the Electrophysics Committee of the American Institute of Electrical Engineers. The lectures will be given in the Auditorium of the Engineering Societies Building, New York City, on the evenings of Mar. 18 and 25, and Apr. 1 and 8, and the lecturer will be Prof. Edwin P. Adams, of the Palmer Physical Laboratory, Princeton University.

The Alaska Railroad Commission, appointed by President Taft in August, 1912, to conduct an examination into the transportation question in the Territory of Alaska, from the engineering, financial and development standpoints, has made its report, the principal details of which are brought out in a special message to Congress from the President, under date of Feb. 6.

The Commission, consisting of Major J. J. Morrow, A. H. Brooks, L. M. Cox and C. M. Ingersoll, recommended as a result of their investigations that two independent railroad lines be constructed, one connecting the Yukon and Tanana River valleys with tidewater, by way of Cordova, Chitina and Fairbanks, and the other running from Seward around Cook Inlet and connecting with the Kuskokwim and Susitna River systems.

Cordova is indicated by the Commission as the logical and best terminal for the Bering River coal fields, and Seward occupies the same position with respect to the Matanuska field. The proposed terminals at Katalla and Controller Bay were deprecated as lacking in the essential factors of good harbor facilities and economy.

The two roads advocated would involve 733 miles of new construction at an estimated cost of $35,000,000, not including branch lines for local development, for which probable future growth the route has, however, been partly planned.

PERSONALS

Mr. W. S. MacCulloch has been appointed Assistant Engineer of the Grand Trunk Ry., at Montreal, Que.

Mr. Geo. W. Craig, Assoc. M. Am. Soc. C. E., has resigned as City Engineer of Omaha, Neb., to become City Engineer of Calgary, Alta.

Mr. W. B. Way, Assistant Superintendent of the Canadian Pacific Ry., at Montreal, Que., has been promoted to be Superintendent at Farnham, Que.

Mr. D. McCoe, Superintendent of Grade Separation, Grand Trunk Ry., Toronto, Ont., has been made Superintendent of Tracks of the Toronto terminals.

Mr. Henry Ferguson, formerly General Road Master of the Grand Trunk Ry., at Toronto, Ont., has been appointed Superintendent of Tracks of the Ontario division.

Mr. Charles Dorrance, Jr., M. Am. Inst. M. E., formerly Fuel Engineer of the Lehigh Coal & Navigation Co., has been promoted to be Chief Mining Engineer, having superintendence of the mining and mechanical departments.

Mr. Joseph Chidley, formerly Division Master Mechanic of the Lake Shore & Michigan Southern Ry., at Collinwood, Ohio, has been promoted to be Assistant Superintendent of Motive Power, with headquarters at Cleveland, Ohio.

Mr. B. R. Pollock, recently promoted to be General Manager of the New York, New Haven & Hartford R.R., has been made General Manager of the transportation department of the Boston & Maine R.R., with headquarters in Boston, Mass.

Mr. Julian Kendrick, M. Am. Soc. C. E., has resigned as Chief Engineer of the Rudolph S. Blome Co., of Chicago, Ill., and opened an office in the First National Bank Bldg., Birmingham, Ala., as a consulting, municipal and hydraulic engineer.

Mr. Thomas E. Collins, Assoc. M. Am. Soc. C. E., Assistant Engineer on the revaluation of the railways and canals, State of New Jersey, has been made city surveyor of Elizabeth, N. J., succeeding Mr. W. H. Luster, Jr., M. Am. Soc. C. E., resigned.

Mr. J. A. Shepherd, formerly General Manager of the Western Maryland Ry., has been appointed Superintendent of the Kansas City terminals of the Missouri Pacific Ry., with headquarters at Kansas City, Mo., succeeding Mr. J. A. Somerville.

Messrs. Robert D. Hennen and G. B. Hartley announce that they have formed a partnership under the firm name of the Monongahela Valley Engineering Co., with offices in Morgantown, W. Va. The firm will engage in both civil and mining engineering.

Mr. Henry L. Gray, M. Am. Soc. C. E., Chief Engineer of the Public Service Commission of the State of Washington, Olympia, Wash., has resigned. Mr. Gray will return to private practice, specializing in appraisal engineering, with offices at Seattle, Wash.

Mr. F. S. Burroughs, Assoc. M. Am. Soc. C. E., formerly Assistant Chief Engineer of the Public Service Commission of the State of Washington, has been appointed Chief Engineer, succeeding Mr. Henry L. Gray, M. Am. Soc. C. E., resigned, as noted elsewhere.

Mr. T. N. Jacob, M. Am. Soc. C. E., has been reappointed Chief Engineer of the East Side Levee and Sanitary District, East St. Louis, Ill., under the new organization of the board of trustees. The office of Consulting Engineer, formerly held by Mr. J. A. Ockerson, M. Am. Soc. C. E., has been abolished.

Mr. E. G. Hewson, formerly Resident Engineer of the Grand Trunk Ry., at Toronto, Ont., has been promoted to be Division Engineer of the Ontario division. The grade of Division Engineer is a new one in the Grand Trunk Ry. organization, which has hitherto had only a Chief Engineer and his staff of Assistant Engineers and Resident Engineers.

Mr. H. W. Beers, recently Chief Engineer of the Southern Ferro-Concrete Construction Co., Atlanta, Ga., has been elected Vice-President of the company. Mr. Beers is a graduate in civil engineering of the Massachusetts Institute of Technology, class of 1906, and has previously been Assistant Engineer and Resident Engineer of the company.

Mr. H. H. Althouse has resigned as Chief Engineer of the Erie R.R. Mr. Althouse has been connected with the Erie since 1899. From 1902 to June, 1912, he was Assistant Engineer at New York. After a short period as Principal Assistant Engineer of the Western lines, he was promoted to be Chief Engineer, August, 1912, succeeding Mr. W. J. Harahan, M. Am. Soc. C. E., now President of the Seaboard Air Line Ry.

Mr. Watson Townsend, Assistant Engineer of the Union Pacific R.R., at Omaha, Neb., has been made City Engineer of Omaha. Mr. Townsend has been in railway work in the Middle West since 1902, when he was a draftsman with the Minneapolis, St. Paul & Sault Ste. Marie Ry. For a short time he was Locating Engineer and later Assistant Engineer of Construction with the Great Northern Ry. He has been with the structural department of the Union Pacific R.R. since 1909. Mr. Townsend succeeds Mr. Geo. W. Craig, resigned, as noted elsewhere.

Mr. T. P. Artaud, Assoc. Am. Soc. M. E., formerly Superintendent of terminals and Purchasing Agent of the Hudson & Manhattan R. R., New York City, has been promoted to be Assistant General Manager, succeeding Mr. O. T. Boyd, resigned. Mr. Artaud became connected with the company during the construction of the Hudson River tunnels and has since steadily advanced through the various departments. In his present office he will have direct charge of the operation of the railway, power house and terminals, as well as act as supervisor of purchases.

Mr. H. W. Irwin has been appointed Assistant Superintendent of Equipment of the Bay State Street Rys., Boston, Mass., which is a system of nearly 1000 miles of track in Massachusetts, Rhode Island and New Hampshire. Mr. Irwin graduated from Purdue University in mechanical engineering in 1903. For a number of years he was with the General Electric Co., Schenectady, N. Y. He entered street railway work as General Manager of the Northern Electric Co., Fargo, N. D., returning to the East in 1909 to become Superintendent of instruction of car service employees for the Boston & Northern Street Ry. and the Old Colony Street Ry.

Mr. E. T. Munger has resigned as General Superintendent of the Hudson & Manhattan R.R., New York City. Mr. Munger graduated from the University of Wisconsin in 1892. He first entered railway work in 1895 as a foreman of construction of the Metropolitan West Side Elevated Ry., Chicago, Ill. In 1898 Mr. Munger was Engineer in charge of the construction of the storage-battery street car line of the Englewood & Chicago Ry., between Englewood and Blue Island, Ill. He again entered the service of the Metropolitan West Side Elevated Ry. in 1903 as Master Mechanic; later he was Superintendent of Motive Power of the company.

OBITUARY

George William Maynard, a prominent mining engineer, died at the home of his sister, Mrs. F. S. Matthews, in Boson, Mass., Feb. 13. He had been in poor health for several years. Mr. Maynard was the dean of the mining engineers of America; he was the oldest mining engineer graduated from the Columbia University, but before its first School of Mines had been established.

Mr. Maynard was born in Brooklyn, N. Y., June 12, 1839. He graduated from Columbia College, as it was then called, in 1859. After graduation he spent a year in the chemical laboratory of Columbia, and in 1860 went to Germany, where for a year he studied chemistry, physics and mineralogy at the University of Göttingen. While there he was a fellow student with J. Pierpont Morgan. Leaving Göttingen he spent a year at Clausthal in the Harz, studying mining and metallurgy in the Bergakademie there. In 1862 he received the degree of Master of Arts from Columbia.

Having completed his studies, Mr. Maynard began his professional practice with an engagement at the Connoree mines in County Wicklow, Ireland, where he remained a year. In 1864 he returned to New York City, where he established an engineering office and chemical laboratory. In April of that year he was called upon to make a professional examination of a mining property in Colorado, which was his first visit to the new mining regions of the Rocky Mountains. He was so much attracted by the possibilities there that in December, 1864, he returned to Colorado and established an engineering office and assay laboratory in Gilpin County, which was perhaps the first institution of that kind in that part of Colorado.

Mr. Maynard returned to New York City in the winter of 1867 and took charge of a sulphuric-acid works on Staten Island. In 1868 he was appointed Professor of mining and metallurgy at the Rensselaer Polytechnic Institute, Troy, N. Y., and occupied that chair until 1873, when the mining department of that institution was discontinued. In 1873 he went to London, England, which was his headquarters during the next six years. During this period he spent six months in Eastern Russia, erecting a copper reduction works for a British company at Voskrevsenky. During this period

he was Consulting Engineer for several iron and steel works in England and Wales, and in such capacity made, at Middlesbrough, the first demonstration in a large way of the Thomas-Gilchrist basic bessemer process of steel making. This brought him into very intimate relations with that lovable character, Sydney Gilchrist Thomas.

Mr. Maynard returned to New York City in 1879 for the purpose of introducing the Thomas-Gilchrist process in the United States, which he succeeded in doing by selling the patents to the Bessemer Co., afterward known as the Steel Patents Co. Subsequent to that time Mr. Maynard remained a resident of this country, save for such brief professional trips as took him abroad. He was engaged in active practice as Consulting Engineer up to the time of his last illness, visiting Nova Scotia, British Columbia, the Yukon, Mexico and Cuba in connection with his mining and metallurgical work.

Mr. Maynard was one of the charter members of the American Institute of Mining Engineers, and many years later he became one of the charter members of the Mining and Metallurgical Society of America. He was also a member of the American Museum of Natural History, the Metropolitan Museum of Art, and the Engineers' Club of New York.

During his early associations with the steel industry Mr. Maynard came closely into contact with many historic characters—Sydney Gilchrist Thomas, Andrew Carnegie, John Fritz and Alexander Lyman Holley, among others—and during his pioneering in the region west of the Rocky Mountains, both in the Northwest and in the Southwest, he had many interesting experiences, reminiscences of which always made absorbing stories when he told them to his friends (Abstract from the "Engineering and Mining Journal.")

ENGINEERING SOCIETIES

COMING MEETINGS

ASSOCIATION FOR STANDARDIZING PAVING SPECIFICATIONS.
Feb. 24. Annual meeting at Pittsburgh, Penn. Secy., J. B. Hittell, 5917 Winthrop Ave., Chicago, Ill.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 25-26. Annual meeting at Indianapolis, Ind. Secy., W. F. King, Indianapolis, Ind.

ONTARIO LAND SURVEYORS.
Feb. 25-27 Annual meeting at Toronto, Canada. Secy., L. V. Rorke, 701 Temple Bldg., Toronto, Canada.

AMERICAN CERAMIC SOCIETY.
Feb. 25-28. Annual meeting at Washington, D. C. Secy., Edward Orton, Jr., Raleigh Hotel, Washington, D. C.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 26-28. Midwinter Convention in New York City. Secy., F. L. Hutchinson, 33 W. 39 St. New York, N. Y.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Feb. 27-28. Annual meeting at Indianapolis, Ind. Secy., A. L. Neereamer, Indianapolis, Ind.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Mar. 3-5. Annual meeting at Chicago, Ill. Secy., W. P. Blair, 824 Engineers Bldg., Cleveland, Ohio.

VERMONT SOCIETY OF ENGINEERS.
Mar. 10. Annual meeting at Burlington, Vt. Secy., G. A. Reed, Barre, Vt.

NEW ENGLAND RAILROAD CLUB.
Mar. 11. Annual meeting at Boston, Mass. Secy., W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass.

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 11-12. Annual meeting at Urbana, Ill. Secy., Edward Bartow, Urbana, Ill.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 18-21. Annual convention at Chicago, Ill. Secy., E. H. Fitch, 900 S. Michigan Ave., Chicago, Ill.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Mar. 19. Annual meeting at Boston, Mass. Secy., S. E. Tinkham, 715 Tremont Temple, Boston, Mass.

AMERICAN CHEMICAL SOCIETY.
Mar. 25-28. Annual meeting in Milwaukee, Wis. Secy., C. L. Parsons, Box. 505, Washington, D. C.

NATIONAL FIRE PROTECTION ASSOCIATION.
Mar. 26-27. Annual meeting in New York City. Secy., Ralph Sweetland, 141 Milk St., Boston, Mass.

NEW ENGLAND STREET RAILWAY CLUB.
Mar. 27. Annual meeting at Boston, Mass. Secy., H. A. Faulkner, 12 Pearl St., Boston, Mass.

DETROIT ENGINEERING SOCIETY.
Apr. 18. Annual meeting at Detroit, Mich. Secy., F. H. Mason, 614 Moffat Bldg., Detroit, Mich.

UTAH SOCIETY OF ENGINEERS.
Apr. 18. Annual meeting at Salt Lake City, Utah. Secy., R. B. Ketchum, 702 Newhouse Bldg., Salt Lake City, Utah.

American Ceramic Society—Among the papers on the program for the annual meeting in Washington, D. C., on Feb. 25-28, are the following: "Use of the Casting Process for Large Clay Wares," by C. J. Kirk; "The Brick Industries of Europe," by G. W. Cronquist; "Pottery Firing by Pyrometry," by E. C. Stover; "The Melting Point of Refractory Materials," by C. W. Kanolt; "Properties of Portland Cement as Affected by Different Burning Temperatures," by P. H. Bates; and "Transverse Tests for Clays," by C. H. Kerr and R. J. Montgomery.

Illuminating Engineering Society—At the annual meeting in New York City, on Jan. 10, the following officers were elected for 1913: President, P. S. Millar; Vice-Presidents, J. W. Cowles (New England), W. J. Serrill (Philadelphia), H. S. Evans (Pittsburgh), and J. R. Cravath (Chicago); Secretary, J. D. Israel; Treasurer, L. B. Marks; and Directors, P. W. Cobb, C. O. Bond and W. C. Morris.

Mining and Metallurgical Society of America—The officers elected for the ensuing year, at the annual meeting in New York City, on Jan. 14, were as follows: President, H. M. Chance; Vice-President, J. R. Finlay; Secretary, W. R. Ingalls, and Councillors, R. A. F. Penrose, Jr., S. W. Mudd, C. W. Goodale and H. S. Munroe.

Plans have been proposed and approved by the governing councils of both organizations, for effecting a union of the Society with the American Institute of Mining Engineers. By the terms of the proposed combination the Society would become the Mining and Metallurgical Society of the American Institute of Mining Engineers, preserving its separate individuality and organization. No action has yet been taken in the matter by the membership of either society.

American Society of Mechanical Engineers—At a meeting in the Engineering Societies Building in New York City on Feb. 11, a paper was read by William T. Donnelly on "Port Facilities for Ships and Cargoes in the United States." The paper dealt almost entirely with conditions at the port of New York. Mr. Donnelly pointed out the essential differences between that and the majority of European ports and gave a very clear and interesting diagnosis of the present congested conditions along the water front of lower Manhattan. His paper explained the contest between railroad and shipping interests for terminal facilities, and also the efforts to relieve congestion by developments along the water front in South Brooklyn and in the Communipaw section of Jersey City. Some attention was given also to the proposed plan for an elevated freight railway along the west water front of lower Manhattan, an alternative plan for an elevated street for pedestrian traffic being suggested. The lecture closed with a series of slides illustrating the differences between the docking facilities and the loading and unloading machinery at European and American ports. H. McLain Harding, S. Sawyer and G. A. Orrok contributed to the discussion.

National Paving Brick Manufacturers' Association—The annual meeting of the Association will be held at Chicago, Ill., on Mar. 3-5, at which time papers will be read on "The Relation of the Trade Journal to Municipal Work," by S. T. Henry, and "The Psychology of Competition," by E. L. Middleton. The date of the meeting was arranged to partly coincide with the dates of the Clay Products Exhibition in Chicago.

Western Society of Engineers—At the meeting held at the Society's rooms, in Chicago, on Feb. 3, a project for a central railway terminal for both passenger and freight traffic was described by Jarvis Hunt. The proposed site is on land owned by various railways, but is traversed by the Chicago River, which would have to be diverted to a new channel. The track plan of the passenger station is peculiar in having separate groups of tracks for inbound and outbound trains, with loop connections, so that there would be no reverse movements. The discussion was chiefly upon matters of detail. The most important points brought out were: 1, the enormous area of land within the business center of the city, which is occupied by freight yards; and, 2, the scattered and inconvenient locations of the numerous freight houses.

A paper on "Railway Bridge Design in Europe and America," by Edward Godfrey, presented at the meeting of Feb. 10, compared the heavy loading for American locomotives (60,000, 64,000 and even 66,000 lb. per axle) with the much lighter loading of foreign locomotives (44,000 lb. maximum for the Prussian State Railways). The foreign practice of providing for periodical inspection was regarded favorably, but the details of design in some small bridges were criticised. Nothing was said, however, as to the design or workmanship on more important structures, except that it was stated that European regulations seem to fail to realise the weakness of hand-driven or field rivets as compared with power-driven or shop rivets.

Other papers listed for the February meetings are as follows: Feb. 17, "Topography of the Bed-Rock under Chicago," by R. Peattie; Feb. 24, "Synchronous Condensers," by L. B. Andrus. This latter meeting will be held jointly by the electrical section of the Society and the Chicago section of the American Institute of Electrical Engineers.